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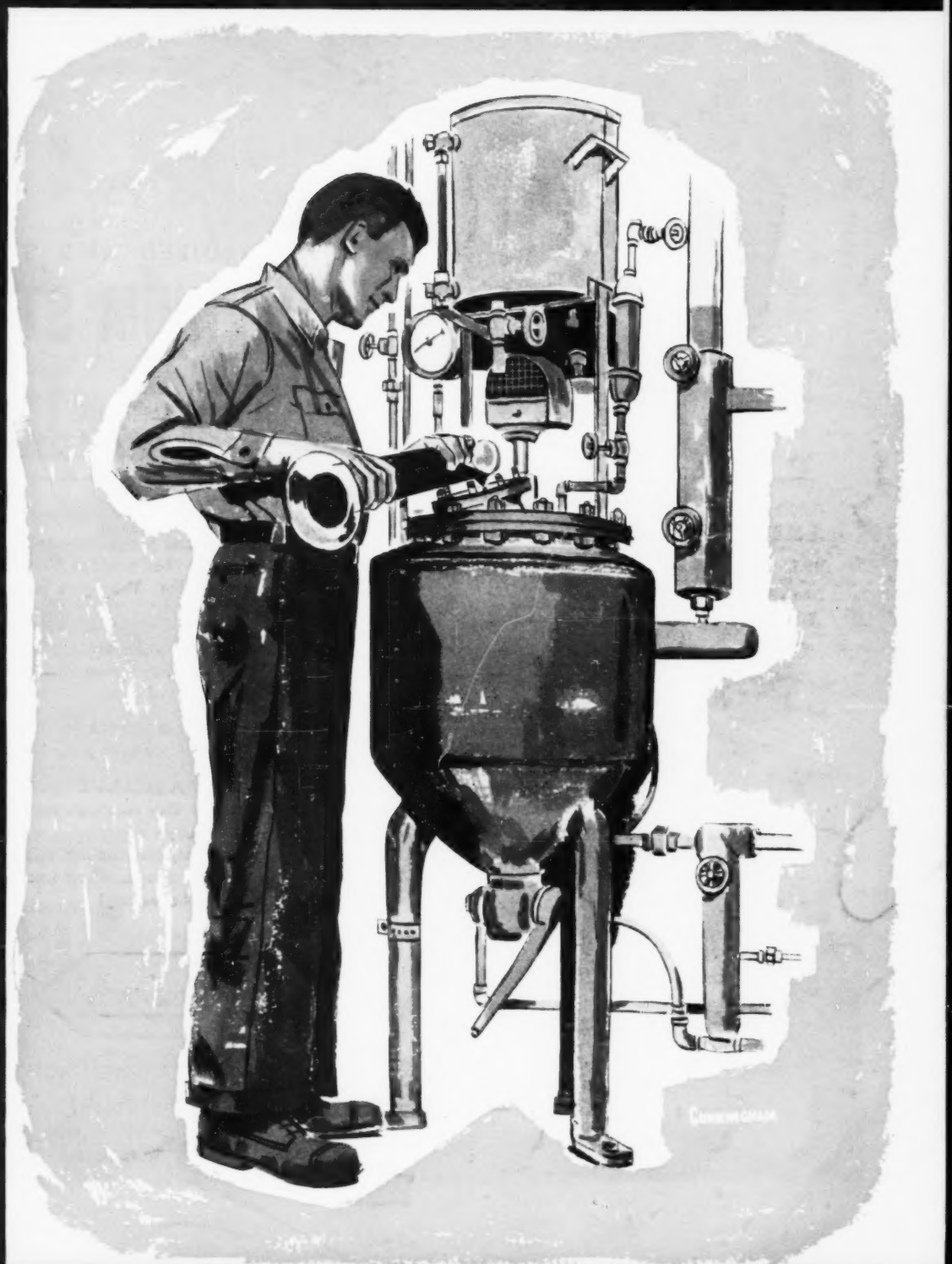

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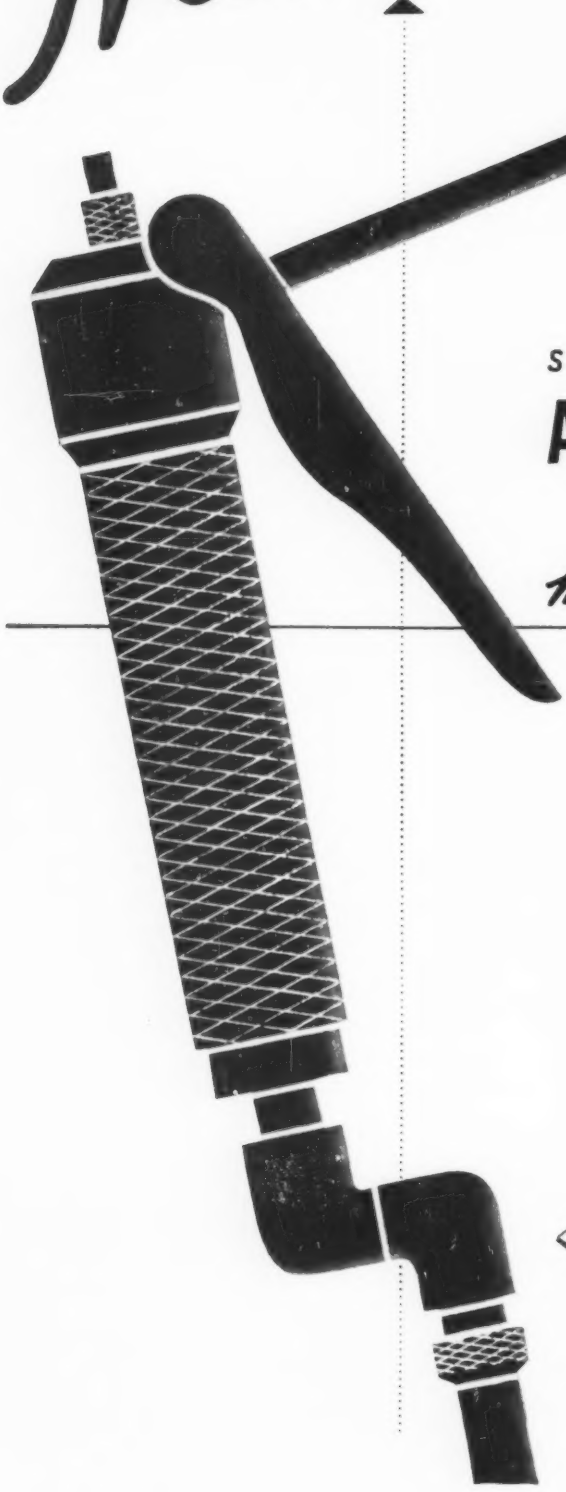

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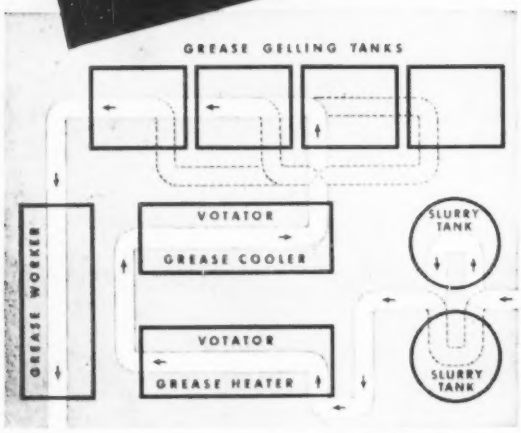

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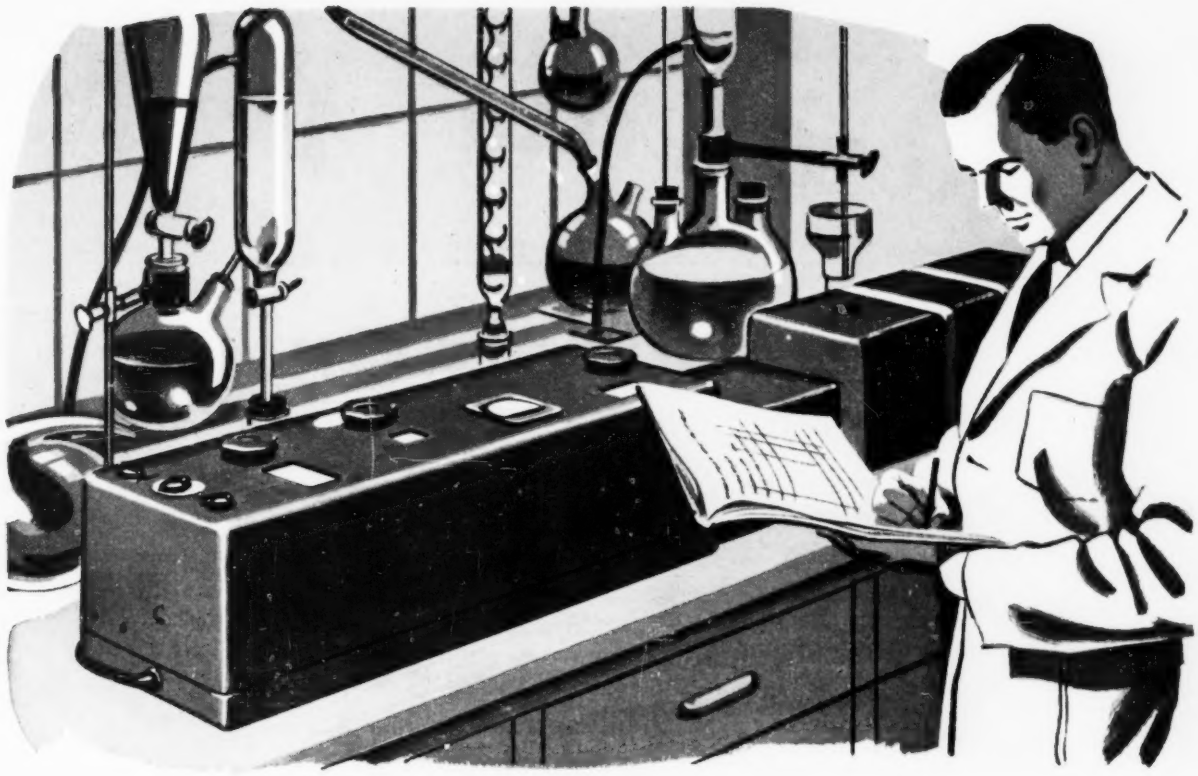

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President's page

by W. Wayne Albright, President, N L G I

LET'S KEEP IT CLEAN

It is not enough to design, make and sell good lubricating grease. No small part of the grease maker's job, is showing his customers how to keep grease clean. He spends a great deal of time, effort and money to see that his lubricating greases are delivered in a perfectly clean condition. From then on it is up to the user to keep it clean.

The User's Responsibility

It is the user's responsibility to supervise grease handling from the time it is removed from the refinery barrel until it reaches the bearing or other application. Improper handling of lubricating greases invites harmful contamination by dirt and water. Grease can get dirty while in storage, while being transferred to another container, or when it is applied to the bearing.

Although present-day grease handling equipment does an excellent job of assisting the grease user, it is only through intelligent supervision that maximum grease cleanliness can be obtained. For example, grease stored in the tightest of barrels can become contaminated if the user is not aware of the disadvantages of storing grease out-of-doors where it is subjected to temperature extremes, rain, snow, hot sun, dirt, etc.

Another danger occurs when grease is transferred from the original container to the dispensing device. Greases, unlike oils, cannot be poured out of a spout. They must be scooped, pumped or forced out by other means. Careless handling is sure to introduce any mount of contamination.

The Third Danger

In the final application of greases to the bearings lies the third danger. Automatic grease lubrication equipment, of course, obviates much of this difficulty. However, by no means is all grease application of this sort. Much of it is by pressure gun or hand application. Again, close supervision is essential to ensure grease cleanliness.

All of these things are known only too well to the NLGI member. What we must all realize is the importance of telling the grease clealiness story and repeating it often enough so that lubricating grease users may receive the maximum benefit from modern lubricating greases.

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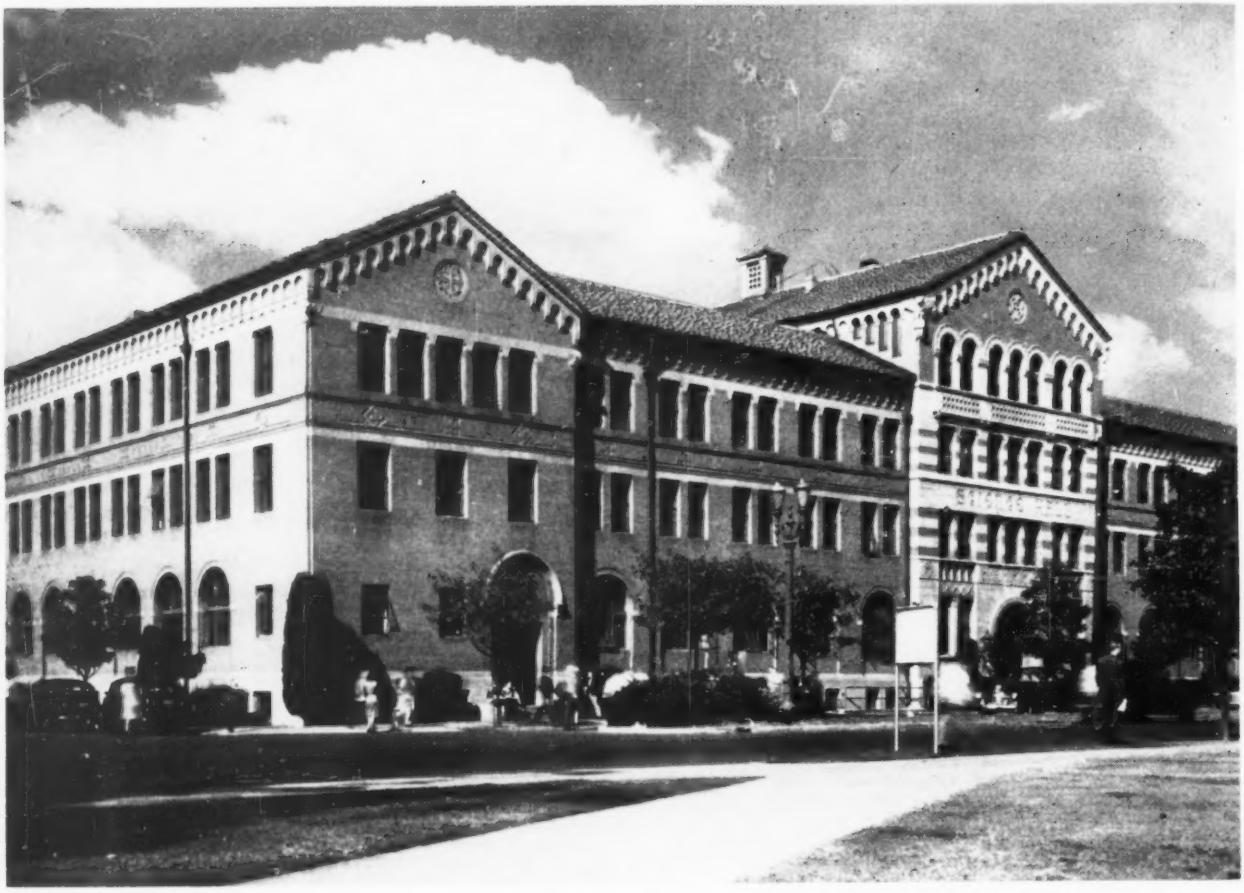
ABOUT THE COVER

The preparation of an experimental grease in a laboratory mixer is depicted on the cover this month by our artist Jim Cunningham. It shows a step used in developing additives.

You'll learn more about this subject in an illustrated article, "Additives for Lubricating Greases," by R. T. Macdonald and J. L. Dreher, in this issue, beginning on page 16. Rust preventives, extreme pressure agents and oxidation inhibitors, the three principal types of additives for lubricating greases, are discussed in detail with respect to need, methods of evaluation and types of effective compounds or materials. Other kinds of additives, such as fillers, coloring agents, additives to eliminate the separation of oil and stringiness agents, are also discussed.



SCIENCE HALL at the University of Southern California is the scene of many a research project.

Organizing and Evaluating An Industrially Sponsored Academic Research Program

Marjorie J. Vold and Robert D. Vold
Department of Chemistry, University of Southern California

Summary

Industrially sponsored academic research provides an ideal medium for building a solid foundation for technical progress, and assuring a continuing supply of imaginative investigators aware of industrial challenges.

Successful operation requires a genuine concordance between the problems of the particular industry and the research interests of the professor. The ideal project provides time to carry out a tedious investigation that may prove valuable, enough personnel to accumulate adequately voluminous data in obviously fertile fields and opportunity to pursue untried fantasies as well. It is limited by the requirement that the professor must provide individual inspiration and guidance. Four to eight students and a three- to five-year review period are suggested as optimum.

Eager and capable students are scarce. Industry can serve itself well in insuring its supply of future research and development men by publicizing the interest and challenge of its fundamental scientific problems.

The development of creative capacity in students should be recognized as one of the returns to industry on its investment, even though the rate of material progress may be slowed by the teaching technique needed to secure this end.

The most productive means of liaison between the industry and the university program is personal conference, and not

reports or publications. It is through this medium that progress in research, measured in terms of establishing contact between industrial problems and keys to their solution, can best be achieved.

Thoughtful managers, keenly aware of the degree of empiricism which pervades their industries, are coming more and more to seek a rational foundation for future progress through direct support of scientific research in universities. For example about a dozen companies, besides the National Lubricating Grease Institute, contribute to the support of research in the chemistry department of the University of Southern California. The general purpose of these contributions is (1) to produce information, methods and ideas useful to the sponsoring industry, (2) to train research men to make creative advances in fields pertinent to the industry and (3) to stimulate interest in the problems of the industry in academic circles. This paper presents an outline of the considerations affecting the success of such a program, including choice of institution and professor, selection of specific program, personnel problems, measurement of progress and liaison with the sponsoring industry.

Choice of Institution and Professor: It seems essential to the success of a joint program that the problems of the industry should fall logically into the channel of the university man's interest. Neither can be long distorted, and considerations of geographical proximity, personal acquaintance and respect, over-all professional status, or aggressive salesmanship on one side or the other, however telling initially, cannot compensate in the longer view for a nicely matched coincidence of industrial and academic objectives.

Regardless of the breadth of their teaching assignments and the seeming diversity of their individual researches, most university men have relatively channelized interests. The particular channel is not always defined by either the substances studied or the experimental techniques employed. For example, the authors rather resent being called soap chemists, even though well over half their published papers deal with soaps. The channel in their case is the hypothesis that phenomena involved in the aggregation of colloidal particles are subject to rational interpretation only if the factors involved are properly identified and evaluated. Greases present a challenge to this hypothesis. So do detergency, clay gels, pigment dispersions, compacted granular solids, and liquid crystals. The list could be lengthened indefinitely.

Discussions preliminary to the implementation of an industry-sponsored program should include the university man's steeping himself in the problems of the industry from raw materials all the way through customer service problems to dreams of future developments—reading patent and technical literature as well as scientific literature, talking with the men in the plant, the sales department, the control laboratory as well as research men and top management. Industry's representatives in turn need to become fully cognizant of the university man's viewpoint, his work habits, his concepts of his research goals and the availability of student personnel and equipment. True mutual understanding goes much deeper than the superficial coincidence, "You have worked on soaps and we use them in greases so let's get started working together."

Selection of Problem: A university man's primary qualification is a capacity to generate ideas. It is no idle boast to assert that the authors could spend two days in a plant and write down at least a hundred specific experimental projects, any one of which might contribute to product or process improvement. The problem is to select for study those most likely to be valuable, and which include the educational function, develop a student's creative talents, contribute to fundamental knowledge, industrial value, and practical feasibility. The authors have developed a species of yardstick for this purpose which is presented in tabular form on the next two pages. To lend specificity to what might otherwise be a frustratingly abstract discussion, this yardstick is applied to three specific projects pertinent to the lubricating grease industry.

Project I represents a gamble in investing a large amount of effort to explore a very restricted system in great detail in the hope that an existent qualitative speculation can be

PROGRESS on any one topic is stimulated by discussion of related problems. Here is part of the Colloid Group at U.S.C.: (clockwise) John N. Phillips discusses light scattering by soap solutions in a group with M. J. Vold, I. Reich, A. M. Woodin, P. Sanyal, K. J. Mysels, R. D. Vold, J. Pfeiffer, P. Mukerjee, E. Stanley, R. J. Williams and H. Scouloudi.

Topics currently under investigation include: Orientability of assymetric particles (M. J. Vold); X-ray diffraction (E. Stanley and H. Scouloudi); Particle flocculation and dispersion in detergent media (I. Reich and A. Phansalkar); Oleophilic clay gels (P. Mukerjee, P. Sanyal and J. Pfeiffer); Aggregation in keratin solutions (A. M. Woodin); Diffusion of Colloidal micelles (R. J. Williams).

Initial Evaluation of Research Proposals

Project I: To determine by conventional techniques of X-ray crystallography, the complete atomic arrangement of soap molecules in calcium stearate and calcium stearate mono-hydrate in order to test the hypothesis that a growth pattern for the crystals leading to a filamentous, oil-enclosing structure is possible for the hydrate but not for the anhydrous material, and that this difference accounts for the role of water in stabilizing calcium greases.

Project II: To determine the phase diagrams of several soaps in a selection of petroleum oils with a view to defining the phase state of the grease at each stage of its manufacture and use.

Project III: To obtain electron micrographs of grease slices to permit direct observation of secondary colloidal structure and trace its development or destruction during grease processing and use.

	Project I	Project II	Project III
FACTOR A EDUCATIONAL VALUE			
1. Is there a reasonable balance between routine requirements and diversity of experimental procedures?	1. *No.* An exorbitant amount of routine calculation is involved. Mastery of the technique itself would take considerable time from the real goal of the project.	1. *Yes.* Though no technique is overly difficult, several are needed and the data are useful as they are gathered rather than all being needed before any can be used.	1. *Uncertain.* Preparation of samples can prove very exacting and troublesome. Experimental work is likely to be more time consuming than desired, but perhaps not prohibitive.
2. Can the student be reasonably expected to generate creative ideas about the project as it proceeds?	2. *No.* Test of the hypothesis requires prior assembly of the complete data.	2. *Yes.* He can interpret the data to obtain the phase diagram and speculate on the factors controlling the composition and temperature limits for each form.	2. *Yes.* These would concern the origin of the structures seen and how to test the hypotheses by modifications and extensions of the experiments.
3. Are related problems under investigation so that the student can profit from group discussion?	3. *Yes.* There are many problems of gel stability under way in the group, and similar crystallographic studies in the field of aqueous sodium soap systems.	3. *Partly.*	3. *Yes.*
FACTOR B FUNDAMENTAL INTEREST AND IMPORTANCE			
1. Are the data of lasting value apart from the particular hypothesis under test?	1. *Yes.*	1. *Yes.*	1. *No.*
2. Is there a reasonable prospect that the data can be interpreted to contribute to solution of an outstanding problem?	2. *Uncertain.* Correlations between growth habit and ultimate structure of crystals is an almost virgin field.	2. *No.* Factors governing solubility relations are not well enough understood for the fairly complicated relations existing to be easily explained in terms of fundamental theory.	2. *Uncertain.* There is still some doubt as to the relation of the structures seen to the structures existing in the gel.
3. Will the results obtained be capable of generalization?	3. *No.* Crystal structures are specific enough to make generalizations dangerous. Limited extensions to other calcium soaps might be feasible.	3. *Yes.* To a limited extent in that result will define which parts of the phase behavior are predictable from that of related materials and which are highly specific.	3. *No.* That is, such a result is not to be anticipated although qualitative relations between structure and treatment of the gel surely exist.
4. Is there a really novel or pioneering hypothesis under test?	4. *No.* The hypothesis is hardly more than a restatement of experimental fact.	4. *No.* Theoretical prediction of phase behavior is not possible at present.	4. *Yes.* To a limited extent it may now be possible to examine the nature of junction points in a gel.

5. Is a new technique involved which is of potential value for other investigations?	5. *No.*	5. *Partly.* The techniques are not new but full adaptation to the present systems might be considered worthwhile.	5. *Yes.*
FACTOR C INDUSTRIAL INTEREST AND IMPORTANCE			
1. Can systems of commercial interest be expected to behave like those under direct study.	1. *Partly.* Disposition of water in the calcium soap lattice is likely to be the same for calcium tallow soaps. Or *uncertain,* since calcium oleate and other unsaturated soaps may behave differently; or growth patterns may be affected as much by oil constituents as by soap crystal structure.	1. *Yes.* At least probably on the basis of existing information.	1. *Uncertain* or *partly.*
2. Will the methods be useful to derive similar data about commercial systems?	2. *No.* Development of suitable crystals does not occur.	2. *Yes.*	2. *Uncertain* or *partly.*
3. Is the project directed toward explaining a specific and recognized phenomenon in the industrial field?	3. *Yes.*	3. *Yes.* Among others, the relationship between the amount of grease of given penetration obtainable from a given weight of soap as a function of blending condition.	3. *Yes.* Rheological and stability properties.
4. Are specific suggestions for product or process improvement likely to be evident as a result of the experiments?	4. *No.*	4. *Yes,* probably.	4. *Yes,* possibly.
FACTOR D PRACTICAL FEASIBILITY			
1. Is the required equipment available?	1. *Partly.* Crystals must be grown; a precession camera would have advantages over the Weissenberg camera we have.	1. *Yes.*	1. *Yes.*
2. Can it be operated by a student with appropriate safety?	2. *Yes.*	2. *Yes.*	2. *Yes,* with available expert technical assistance.
3. Can a diligent student make good progress in about a year's time?	3. *Uncertain.* It is possible that the crystal structure is complicated enough to defy analysis by present methods.	3. *Yes,* or even in less than a year's time.	3. *Yes.*

subjected to quantitative test. Project II represents a relatively routine study which could, nevertheless, be of considerable value. Project III represents a pioneering study in a field well enough defined to guarantee worthwhile discoveries insofar as any prophecies of this sort are dependable. A fourth type of project consists in exploring a nebulous hypothesis in order to determine whether it can be formulated as a defined project and evaluated for further study with student collaboration. Two examples are (a) whether nonrandom orientation of soap particles produced by shearing can be evaluated experimentally and used as a tool to characterize and explain any rheological properties of greases, and (b) whether the observed intensity fluctuations in x-ray diffraction patterns of soaps extracted from greases can be

systematized and related to some characteristic of the soap useful in explaining grease properties.

The ideal program is large enough to include all four sorts of research, and carries a sufficient presumption of continuity so that (a) time invested in gambles is not too high a proportion of the whole, (b) a worthwhile volume of data can be obtained in pursuing problems of types II and III, and (c) new ideas can be tried out rather than shelved as soon as the preliminary exploration has been completed and other new ideas generated to clamor for investigation. A three- to five-year term is desirable.

The university professor is basically a teacher. He is neither an administrator coordinating the efforts of a research team nor an investigator with a staff of technicians in his employ. He thinks with, and not for, his students. To be effective, he must spend considerable time with each. His primary responsibility is to develop in them the capacity for creative effort. Large numbers of graduate students cannot be handled effectively at any one time. The precise optimum number varies of course with the professor, with the students, and other circumstances. The authors are inclined to set about four to eight in one general field, distributed as to degree of advancement, as a practical ideal.

Recruitment and Training of Personnel. At the present time there is an insufficient number of qualified students at every level of advancement from the eager but slightly irresponsible undergraduate thirsting for the glamor of research to the post-doctoral student seeking to broaden his horizons before embarking on an independent career. In the face of this situation it is unrealistic to enlarge upon the characteristics of an ideal project staff, although a few observations are in order as to its composition.

Provision should be made for some direct participation by the university professor at the experimental level. There should be, in addition, at least one post-doctoral student who can match wits with the professor and lead the younger students to do the same, by example as well as precept. There should be undergraduates who come in after an afternoon laboratory session of following the book and getting the answer, to learn the problems involved in obtaining and evaluating a new fact, and the thrill of being right after a dozen failures. But the backbone of the project should be the pre-doctoral candidate who is given time to master the field and make his contribution to it while developing from schoolboy to scholar.

Recruitment of such a group does not consist only of placing an advertisement and screening the applicants. It begins with encouraging able young people to seek careers in colloid chemistry and in providing a climate in which their initial enthusiasm cannot help but grow. Publicizing the challenge of its scientific background is the greatest contribution any industry can make to insuring a future supply of capable technical men. Children will force the purchase of a particular cereal to send the box-top and fifteen cents away for a genuine cosmic ray gun. They would do the same with a lubrication receipt for Slippy's Grease to get a chemicals kit and instruction booklet in colloid chemistry. Even adults hum the tunes of the singing commercials. Help them to sing to the challenge of improvements yet to be made,

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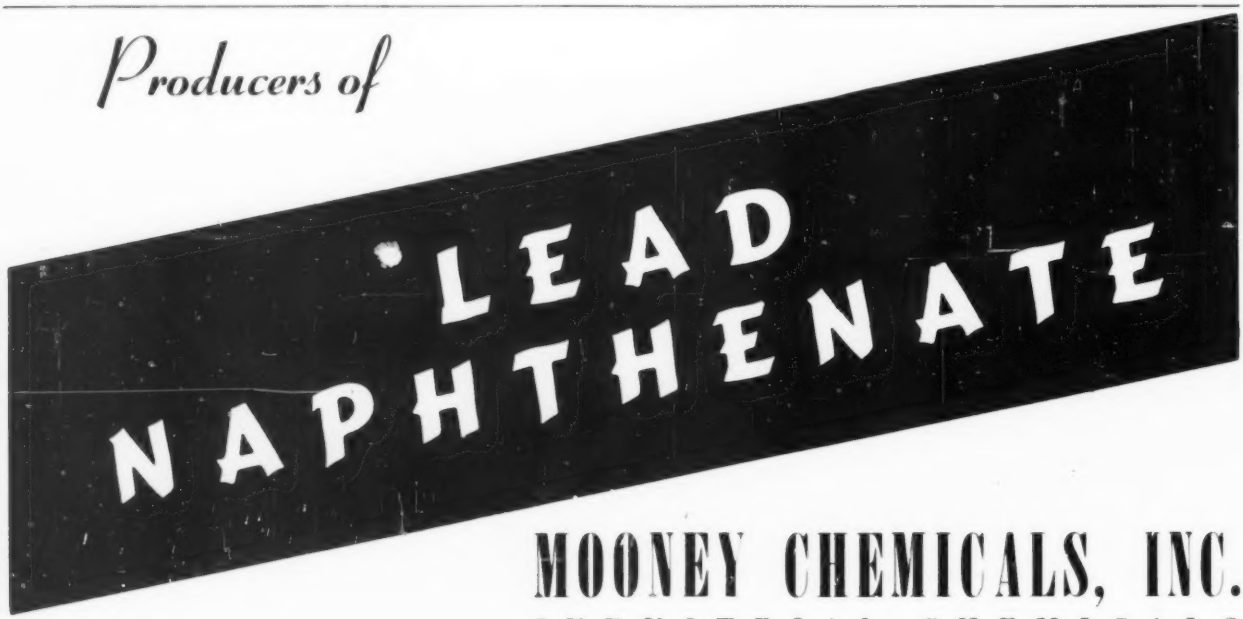

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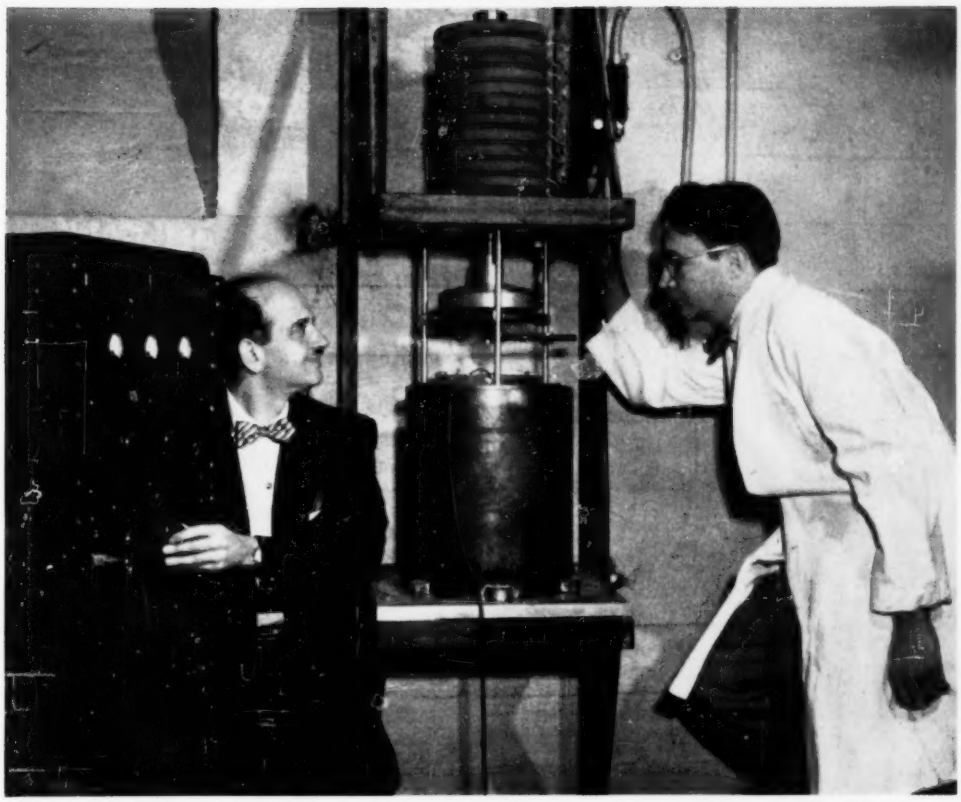

CONSTANT CHANGE AND DEVELOPMENT as well as expert maintenance service are needed for electronically controlled instruments in colloid research. Here Instrumentologist Jon Myer (right) is shown with Prof. K. J. Mysels inspecting the magnetically suspended ultracentrifuge rotor designed by Mr. Myer.

not for a million dollar profit but for the satisfaction of discovery.

The university has the responsibility of generating and preserving creative enthusiasm. We are constantly seeking to improve our techniques for doing this. Progress seems slow, and there are a variety of contributing causes centering around human frailty. The goal is to help the students to learn to think creatively.

We used to require a candidate for the degree of Doctor of Philosophy — traditionally the mark of the mature scholar — to pass comprehensive written examinations demonstrating his acquaintance and deep understanding of all the broad fields of chemistry. Now we ask him to devise a research project — or several — in a field of his own choosing: "You want to be a research man — then you need to be able to see what needs doing and how to do it." We ask him to evaluate his projects in terms of intrinsic importance, relation to the general field of knowledge, and feasibility, and require him to defend his evaluation. Successful performance on either type of examination guarantees possession of a substantial fund of factual information but the latter carries a positive challenge while the former depends only on diligence and comprehension.

When our sights are thus focussed on the development of creative talent, tangible results of a research program may appear only slowly as compared to the productivity of an arrangement whereby the research director and a few chosen experts govern a corps of student technicians. The professor might tell the student exactly what to do. Yet he should patiently withhold his suggestions and leave the student to puzzle and fumble for weeks over a difficulty the professor could probably overcome in a day or so. At the end of the professor's two days only the material problem would have progressed, not the student. For the success of a program of industrially sponsored research, the industry, as well as the university, must be convinced of the necessity of patience in producing research men as well as data.

Measurement of Progress in Research. Inasmuch as the purpose of research is to find the truth, its progress can be measured only in terms of the truth found. It cannot be measured in dollars or publications or patents or any other similarly incommensurable units. It is measured by answering three simple questions at frequent intervals. Have the answers to the questions posed at the beginning of the interval been found? Has anything else been discovered that seems significant? Has it been found that the initial approach was wrong and a new one devised? If any one of these can be answered affirmatively then progress is being made.

These criteria are best applied as often as possible, surely no less frequently than at weekly intervals, and more elaborately in the form of semi-annual or annual summaries. Such reports are not intended for publication nor for distribution to sponsors. The purpose of such measurement is to facilitate intelligent guidance of the program rather than to justify it.

Liaison. This word means intercommunication or the establishment of connecting bonds and coordination of activi-

LONG-TERM FUNDAMENTAL RESEARCH is a necessary part of a well-rounded program. Here Dr. Helen Scouloudi adjusts a soap crystal prior to taking a Weissenberg X-ray photograph.

ties. It applies both to the sponsoring industry and to the scientific world generally through the media of personal contacts, correspondence and publications. Of these, the personal contact is the most valuable in realizing the objectives of the whole program both in catalyzing industrial progress and in stimulating widespread interest in the problems of the industry in scientific circles. At such conferences ideas and problems can be discussed freely and there is maximum probability of sudden insight which may provide the key to the solution of a previously baffling practical prob'em.

Publication serves a different purpose. The printed word carries an implication of final verity that should engender caution in its use. Voluminous and hasty publication for the sake of display, far from stimulating progress, serves only to breed contempt on the part of intelligent readers not only for the authors but for the entire subject field. Publication should be undertaken only when the research group is convinced that an account of its results can be a lasting contribution to the structure of knowledge.

In the opinion of the authors, therefore, the ideal program should provide, as its principal liaison, mechanism for regular annual conferences between the academic research group and the industry, and for attendance at technical and scientific meetings.

The Challenge

In our times we face significant alternatives in many fields —freedom versus slavery, materialism versus idealism, progress versus decline in all things. The university has always been a center nurturing the seeds of progress.

DIRECT PARTICIPATION by the professor at the experimental level is a desirable feature of university research. Here Irving Reich (right) discusses and demonstrates to Prof. R. D. Vold a device for controlling foaming, as suspensions are formed by mechanical dispersion in detergent solutions.

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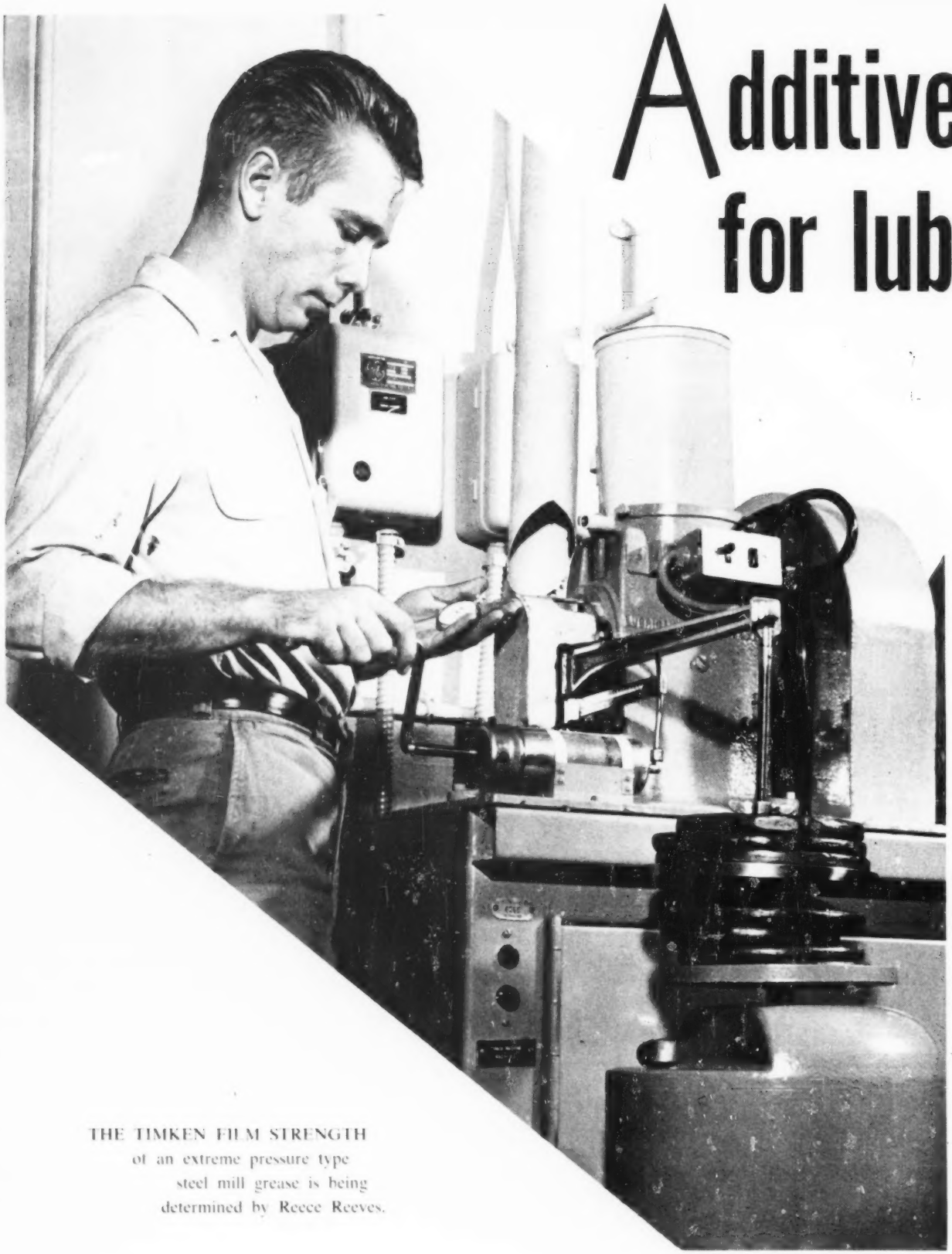


THE TIMKEN FILM STRENGTH of an extreme pressure type steel mill grease is being determined by Reece Reeves.

cating greases

R. T. Macdonald and J. L. Dreher
California Research Corporation
Richmond, California

Abstract

Although "additives" in lubricating oils have been in use almost since the beginning of the oil industry, the greatest progress in their use has been to supplement or add new properties. This has taken place in the past 15 years.

More recent than this development is the extensive use of additives in lubricating greases. They permit greases to provide superior protection against rust, carry much higher loads and permit greatly extended useful life in storage and application.

For the first time, the whole subject of how the use of additives can fortify or add new properties to lubricating greases is brought together in one paper.

Introduction

In line with its competitive nature, American industry is constantly demanding longer operating periods of its equipment and improved performance of its products. For example, there is a constant drive in the steel mills to operate at higher speeds and greater loads. Electric motors with heat resistant insulation are being built to run at higher temperatures. Airplanes are operating over wider temperature ranges. As a consequence of this persistent increase in the severity of operating conditions, there is a constant demand for lubricants with improved performance with regard to characteristics such as oxidation stability, load carrying capacity, and rust prevention.

In order to meet this demand for better performance, it has been necessary to develop special materials which impart the desired properties to the lubricants. Without these additives, the lubricants, whether made with mineral or synthetic oil, frequently fail to meet the requirements. The modern motor oils, gear lubricants, and turbine oils are excellent and well known examples of the benefits derived through the use of additives. Although less widely publicized, greases have closely paralleled oils with respect to the use of additives.

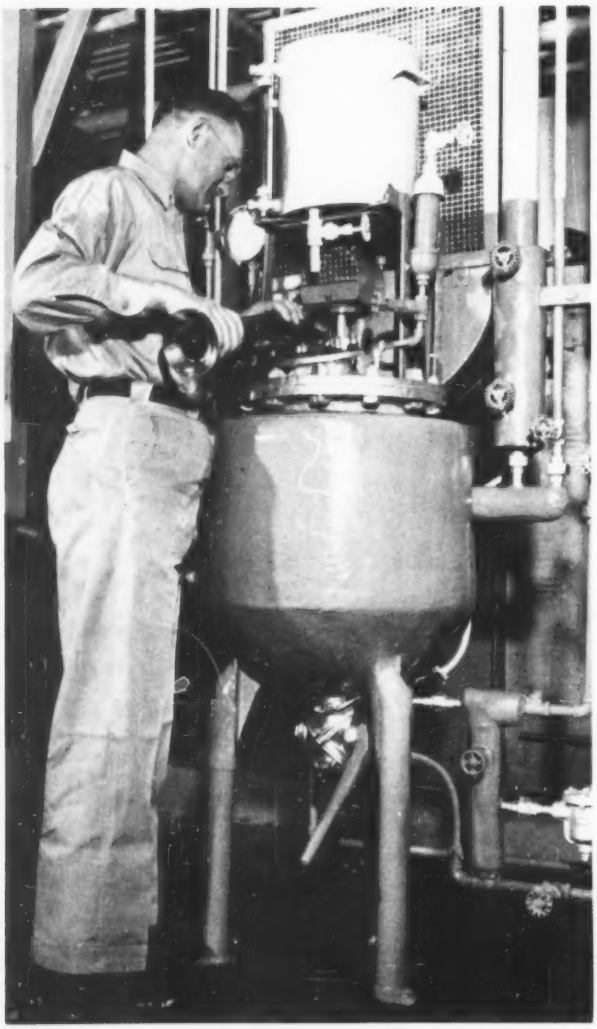
In general, the additives used in greases are of the same type as those used in oils; however, they are usually employed at higher concentrations in greases.

While many additives behave similarly in oils and greases, there are frequent exceptions to the rule. Also, the response obtained through the use of an additive will differ with different types of greases; for example, the best rust preventive or extreme pressure agent in one type of grease may not prove to be as effective in another type of grease. Further, the presence of the thickener interferes with the activity of some additives. For example, the thickener, particularly if it is a soap, often acts as an oxidation catalyst. Also, rust preventives and extreme pressure agents can be adversely affected by the thickener.

The three principal types of additives for greases are rust preventives, extreme pressure agents, and oxidation inhibitors. These will be discussed in detail with respect to need, methods of evaluation, and types of effective compounds or materials. The other kinds of additives, such as fillers, coloring agents, additives to eliminate the separation of oil, and stringiness agents, will be discussed only in a general way.

Rust Preventives

When a grease lubricated bearing operates under conditions such that moisture is likely to be encountered, it is imperative that the grease not only be a satisfactory lubricant but also be effective in the prevention of rust. The end result is the same to the customer whether a bearing fails because of the lack of lubrication or because of excessive rust, and therefore he has come to expect the grease to be also a rust preventive.



EXPERIMENTAL GREASE is prepared in a laboratory mixer by Lloyd Dicely.

Wheel bearing grease is an excellent example of a grease which should be effective in the prevention of rust. Despite the precautions taken in sealing, water occasionally enters the hub and comes in contact with the bearings. Excessive rusting has been found in passenger car wheel bearings in California after a period of about four months during which heavy rains were experienced. Rust is also encountered in the wheel bearings on airplanes. It is for this reason that General Purpose Aviation Greases conforming to Military Specification MIL-L-7711, which are generally recognized as having poor rust preventive properties, have been replaced as aviation wheel bearing lubricants by High Temperature Greases (MIL-L-3545), whose better rust preventive properties are attributable in part to the use of more viscous mineral oils.

As might be expected, one of the most severe tests of the rust preventive properties of a grease is encountered in the canning industry. In a cannery operating in the Santa Clara Valley, handling fruit and vegetable juices primarily, tests were run for a period of two months with a conventional cannery grease and with the same grease containing a rust preventive. The uninhibited grease permitted bad rusting of the seamer roll bearings, while with the rust preventive grease no signs of rusting could be found, and the lubrication was excellent. These examples illustrate the need for and the benefits derived through the use of effective rust preventive compounds.

Numerous test methods have been devised for the evaluation of the protection afforded by greases in the prevention of rust. Some, unfortunately, have given results which contradict field experience. Although this discrepancy may be partly due to unreliable field data, much work remains to be done in the development of a completely satisfactory rust test.

About five years ago SAE Subcommittee S5c was organized to evaluate test methods for aviation greases. In the field of rust tests, five methods were investigated:

1. A Salt Spray Test in which test panels were placed in a synthetic salt spray atmosphere at 95° F.
2. An Immersion Test in which test panels in beakers half filled with distilled water were exposed to the weather for about 300 hours.
3. A Condensation Test in which test panels were subjected to seven or more cycles consisting of two hours at 40° F. and twenty-two hours at 90° F. and high relative humidity.
4. An Emulsion Corrosion Test in which the test panels in the Salt Spray Test were coated with water emulsions of the test grease.
5. A Tide Water Immersion Test in which test panels were clamped to a board and suspended at mean tide level in the ocean.

Of these five tests, the Salt Spray Test, the Condensation Test, and the Emulsion Corrosion Test gave results which were in fair agreement with the available service data. The Salt Spray Test is preferred by the Committee because the test is more convenient to perform and is less time consuming.

This Salt Spray differs in a number of respects from the Salt Spray Test specified in the Automotive and Artillery Grease Specification MIL-G-10924, while the latter test differs in many ways from the test specified in the General Ordnance Grease Specification MIL-G-16908. The differences that exist between these different test procedures may not be significant, nevertheless the grease industry would greatly benefit from a standardized and, if possible, simplified procedure for a salt spray test which would correlate with field experience.

Recently R. J. Burger, B. Rubin, and E. M. Glass, from the Materials Laboratory at Wright-Patterson Field, reported the development of a rust test which uses bearings that are coated with the test grease and suspended in a humidity cabinet at 100° F.[1] In several respects this simulates

[1]R. J. Burger, B. Rubin, and E. M. Glass, Lubrication Engineering, February 1952, Vol. 8, No. 1, page 21.

service conditions more closely than do the Salt Spray Tests. A similar test has been used at California Research Corporation for some time, and to date the results have been in good agreement with field data.

Many widely differing types of surface active compounds are effective rust preventives. Reported in patents and literature are amines, amine salts, metallic sulfonates and naphthenates, esters, and nonionic surfactants. They are probably effective because of their affinity for the metal surface or because they lower the water-grease interfacial tension. The response of the compounds is dependent upon the type of grease. For example, the additive which works best in an aluminum base grease may not be the best in a lithium base grease. Therefore, a compound which has been found to be an effective rust preventive in one type of grease must be tested to determine its effectiveness in any other type of grease.

Apparently in some quarters the terms "waterproof" and "rust-preventive" are used synonymously. This is unfortunate as some "waterproof" (water-insoluble) greases are extremely poor with respect to rust prevention, while many sodium base greases which are relatively water-soluble provide excellent rust prevention. Thus, there is not necessarily a direct correlation between water insolubility and rust prevention.

Extreme Pressure Agents

Extreme pressure or E. P. agents are not used as extensively in greases as in oils. For the most part their use is confined to steel mills where very heavy shock loading is encountered, particularly in the rolling operations. E. P. agents are also used in a variety of other applications such as chassis lubrication, but the need for the E. P. properties in many cases is difficult to demonstrate.

Of the test machines used for the laboratory evaluation of E. P. characteristics of greases, the Timken, Falex, Four-Ball, and Almen are the most commonly used. Of these machines, the Timken Machine is used most and many specifications for E. P. greases require a minimum load carrying capacity of thirty-three pounds on this machine.

To determine the reproducibility of this test method, ASTM Committee D-2 recently conducted a cooperative test program. Oils were evaluated in the first phase of the program and a wide variation in test results was obtained.[5] A similar program is planned with greases, and it is probable that an even greater spread in results will be obtained. However, the program will have been successful if it results in a standardized procedure and establishes the degree of reproducibility of the Timken Machine for the evaluation of the load carrying capacity of greases.

As is well known, E. P. agents contain one or more of the following elements: sulfur, chlorine, phosphorus, and lead. They are prepared by reacting such materials as fats, fatty acids, wax, and mineral oil with compounds such as sulfur, chlorine, sulfur monochloride, phosphorus pentoxide, phosphorus pentasulfide, and phosphorus trichloride. The lead is usually added as a naphthenate, sulfonate, oleate, or stearate soap.

[5]H. Levin, H. G. Sprague, and Collaborators, ASTM Bulletin, April 1952, No. 181, page 43.

In the use of any additive, undesirable responses are frequently obtained as well as the desired one. This is particularly true in the case of E. P. agents. A grease should be re-examined after the addition of an E. P. agent, to insure that significant changes have not occurred in such properties as consistency, dropping point, bleeding characteristics, and corrosivity.

The increase in Timken Film Strength obtained through the use of E. P. agents is largely dependent upon the thickener that the grease contains. For example, it has been found that with a calcium base grease, a lithium-base grease, (both contained 2.5% lead soap also), and a Bentone grease, three different amounts of an E. P. agent are required to obtain a Timken value of 35-40 pounds, a value safely above the usual requirement. This is shown by the data in Table I. The viscosities of the three oils used in the three greases were in the range of 75 to 100 SSU at 210° F., and the E. P. agent contained sulfur and chlorine.

Table I

Effect of Thickener on E. P. Agent Response (35-40 Pound Timken Value)

	Concentration of E. P. Agents, Wt. %	
Thickener	Sulfur-Chlorine	Lead Soap
Calcium Soap	5	2.5
Lithium Soap	10	2.5
Bentone	2	....

It is particularly difficult to obtain high Timken Film Strength values in the lithium-base greases and also to obtain values which do not decrease as the greases age. The loss of film strength that frequently occurs with lithium-base E. P. greases is shown in Table II. Each value is the average of at least three determinations with a mean deviation of three pounds. It can be seen from the data that an unusually high concentration of the E. P. agents was required to achieve an original Timken Film Strength value of 40 pounds or more, and that after the greases were stored for one month the decrease in load carrying capacity ranged from ten to fifteen pounds. After approximately one month, according to limited data, the load carrying capacity remains constant. It is possible through the use of auxiliary compounds, which do not contain any of the usual E. P. elements, to prepare lithium-base greases which remain relatively stable with time.

Table II

Effect of Age of Lithium-Base E. P. Greases on Timken Film Strength Values

Active Element	Wt. % of	Timken Film Strength (Lbs.)	
in E. P. Agent	E. P. Agent	Original	After One Month
1. Sulfur, chlorine,	10	40	30
2. Sulfur, chlorine, phosphorus	10	40	25
3. (1) plus stabilizer	10	40	40

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Oxidation Stability

The need for increased oxidation stability in greases was early recognized with the progressive increase in average bearing operating temperature and the advent of the life-sealed antifriction bearing. At first sight, long operating life was considered to be the only factor, but shelf storage life was also found to be of importance. This has been particularly true with the Armed Forces, whose equipment is, to a large extent, "mothballed" and for which prelubricated replacement parts must be stored. Consequently, it is in this field of grease additives, the oxidation inhibitors, that major advances have been made during the last decade. Today there are greases on the market which give useful lives of hundreds, even thousands, of hours at 300° F. in high-speed ball bearings, and the demand for high temperature greases is not slackening but increasing, with the currently talked-of needs for greases for operation at temperatures over 400° F.

These greases have resulted from a careful choice of oil, thickener, and oxidation inhibitor. Some greases contain synthetics in place of petroleum oils, such as the highly oxidation-resistant silicones, and thickeners other than the catalytically active metallic soaps; but the most widely used are of the conventional soap-mineral oil type stabilized by extremely efficient oxidation inhibitors.

In the development of these greases, many tests have been used, including the bomb oxidation test (ASTM D 942-50), thin film test, bearing tests, and service evaluation. In the first two of these tests oxidation is the only significant variable; in bearing tests deficiencies in other properties such as consistency, texture, fiber structure, and oil separation may be the major cause for the bearing failure long before the grease would have become unserviceable on account of oxidation. Consequently, greases that are long-lived in the bomb oxidation test often are not satisfactory in bearings—and this is recognized in the "scope" of the test method, which states that it correlates only with behavior in thin films under static conditions, such as storage of prelubricated bearings. On the other hand, greases which are not outstanding in the bomb oxidation test can perform very satisfactorily in the closer-to-service type bearing tests.

Even with these limitations the bomb oxidation test is used as a research tool of the screening type, and we shall discuss some findings obtained with this tool.

Bomb Oxidation Test

This test, developed largely by F. L. Wright and often referred to as the Norma-Hoffman Grease Oxidation Test, is well known by the lubricating grease industry. The test procedure is well standardized, and while the test is normally conducted at 210° F., this temperature may be varied. In the work that we shall describe the temperature was generally held at 250° F., although some data at 210° F. are mentioned.

The results may be summarized as follows:

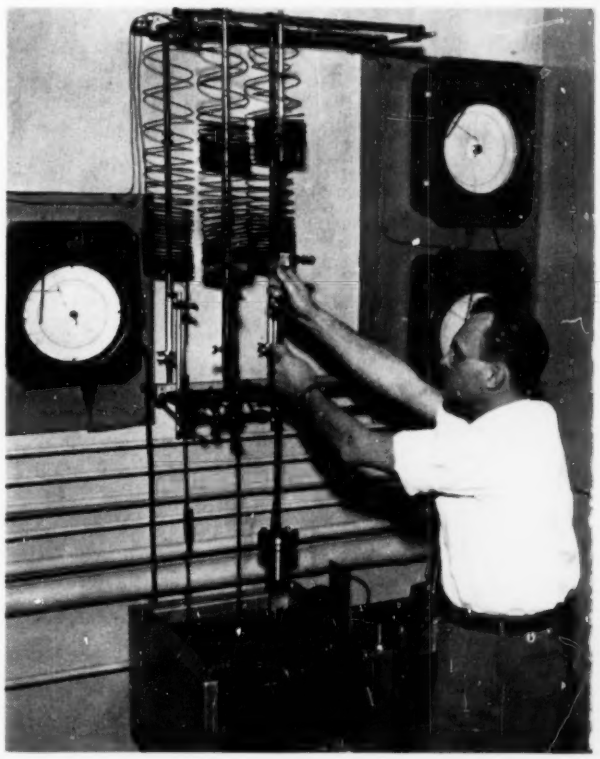
1. Greases thickened with metallic soaps exhibit markedly greater oxygen absorption rates than do the constituent mineral oils.
2. In general, the oxygen absorption rates of greases, prepared with refined mineral oils from the same crude oil, are directly proportional to the degree of refinement of the oil.
3. When such greases are oxidation-inhibited the order of rate of oxidation is reversed, i.e., the rates are inversely proportional to the degree of refinement of the mineral oils.
4. As inhibitor concentration increases, up to about 5%, some inhibitors pass through a maximum of effectiveness, causing increased oxygen absorption rates at the higher concentrations, whereas other inhibitors cause progressively decreasing rates.
5. Of all the inhibitors studied in this work, the dialkyl selenides are the most effective.

Catalytic Effect of Soaps

Figure 1 shows typical bomb oxidation tests at 250° F. with a sodium soap, uninhibited grease, and with the constituent mineral oil of the grease. The marked catalytic effect of the sodium soap is evident. Current research is aimed at offsetting or eliminating this catalysis by the development either of inhibitors of high order of effectiveness or of noncatalytic thickeners.

Degree of Refinement of Mineral Oil

It is well known that the rate of oxidation of a mineral oil is a function of the degree of refinement. Distillate



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stocks are unstable on account of the large concentrations of readily oxidizable compounds present. With the initial treatment, either acid or solvent, the more readily oxidizable compounds are removed, resulting in a marked increase in oxidation stability. However, as treatment is carried further, oxidation stability reaches a maximum and then decreases. It has been established by Denison[3] that this decrease is due to the removal of naturally occurring inhibitors of the sulfur type. Finally, with oils of very deep treatment, such as the white oils, the oxidation stability is as poor as that of the distillates.

The same is true of greases, as shown in Figure 2, which presents typical oxygen absorption curves of sodium stearate greases at 250° F. In each case the viscosities of the mineral oils are comparable so that variations in response due to marked differences in molecular weight and type are not introduced. The characteristics of the oils, all from the same crude oil source and listed in order of degree of refinement, are listed in Table III.

Table III

Oil Components of Greases Shown in Figure 2

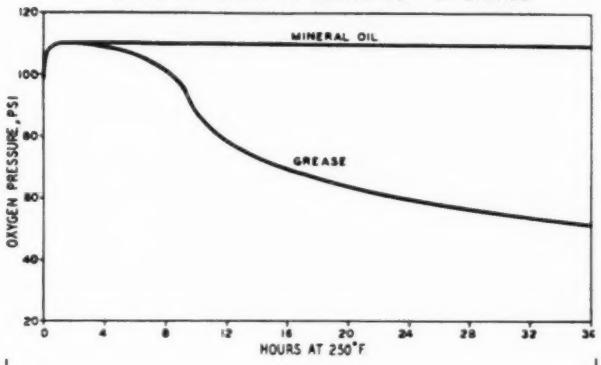
Grease	Mineral Oil			
	Base	Treatment	SSU at 100° F.	V. I.
A	Naphthenic	Light Acid	450	0
B	Naphthenic	Phenol	400	35
C	Naphthenic	Heavy Acid	400	65

It should be noted that the ultimate order of stability is not established at the beginning of each test. Grease A shows an early drop in pressure but later only a slow constant rate of absorption, while Grease B absorbs little or no oxygen in the early stages but rapidly exhibits marked absorption. Thus it is in the overall effect that the rate of oxygen absorption is directly proportional to the degree of mineral oil refinement.

[3]G. H. Denison, Ind. Eng. Chem. *36*, 477 (1944).

Figure 1

CATALYTIC EFFECT OF SODIUM SOAP IN GREASE



Inhibitor Responses vs. Degree of Mineral Oil Refinement

In contrast to the behavior of the uninhibited greases, the addition of normal amounts of an inhibitor causes a reversal in response; that is, greases containing oils of highest refinement show the greatest stability. This is illustrated in Figure 3 which depicts oxygen absorption data on two sodium soap greases, with and without 2.5% of a sulfur-type inhibitor of medium effectiveness. The constituent mineral oils are of low and high refinement similar to those used in Greases A and C of Figure 2. This is the usual response, but exceptions can be found.

Inversion of Effectiveness

Figure 4 illustrates data obtained at 210° F. on two sodium-base greases with a solvent extracted base oil and of the same composition except differing in the amount of an amine antioxidant. Grease D containing 2% of the inhibitor shows an oxygen pressure drop of 4 psi in 100 hours while Grease E with 5.5% inhibitor gives a pressure drop of 8 psi

Figure 2

EFFECT OF MINERAL OIL TREATMENT ON OXYGEN ABSORPTION OF SODIUM SOAP GREASES

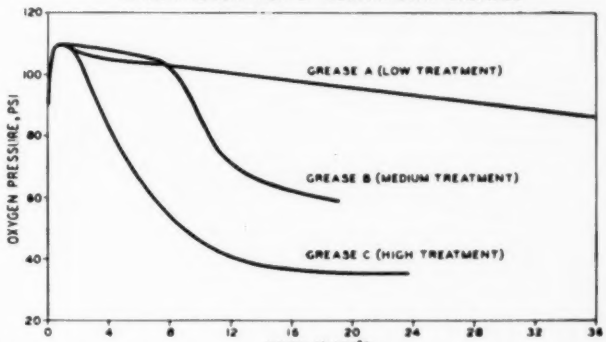
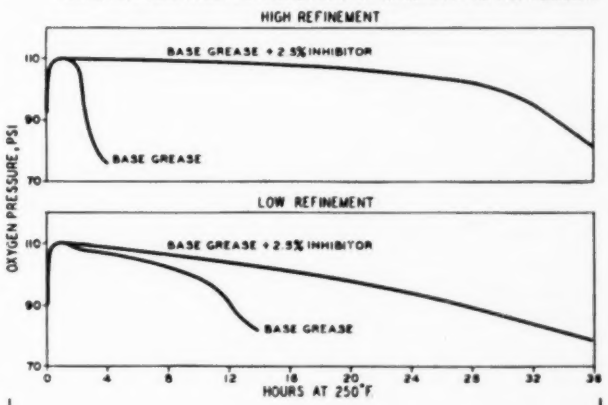
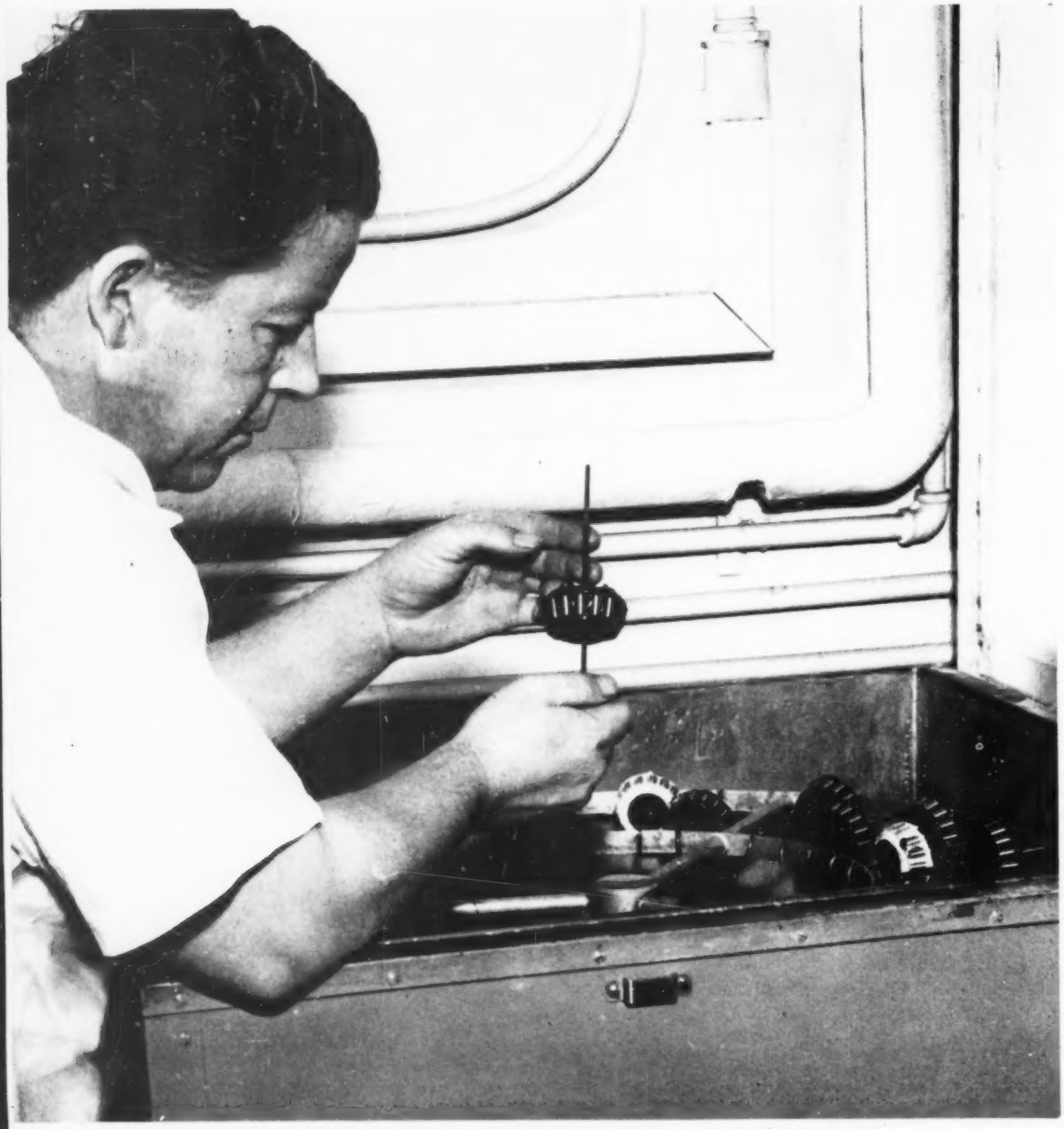


Figure 3

INHIBITOR RESPONSE AS FUNCTION OF MINERAL OIL REFINEMENT





A RUST TEST SPECIMEN is examined by Jack Stapleton. Antifriction bearings are used to simulate service conditions.

in the same time, which is outside the 5 psi limit of most modern specifications. Grease E is also seen to maintain a higher oxygen absorption rate than Grease D to 400 hours. This behavior indicates that at the higher concentration the inhibitor itself is being preferentially oxidized, whereas, at the lower concentration it is acting as a chain-stopper.

Regardless of the mechanism of the reaction in this oxygen absorption test, Grease E appears to be satisfactory for high temperature operation, with an average life of over 1000 hours in the Navy High Speed Bearing Test at 300° F. (Federal Specification VV-L-791d, Method 33.1). Whether or not Grease D will be satisfactory is questionable as bearing tests are still in progress.

These data on Grease E clearly constitute a case where predictions of bearing performance cannot be made on the basis of oxygen absorption data. Furthermore, it is a case opposite to that usually encountered, where the bomb test indicates that a grease shou'd show good resistance to oxidation and, possibly, good bearing performance.

Selenides

Of all the classes of inhibitors investigated to date in our laboratory, the dialkyl selenides (and tellurides), both mono- and di-, are the most outstanding. The higher molecular weight selenides are preferable to the lower; for example, dilauryl selenide is more effective than dibutyl.[1]

The outstanding character of the selenide-inhibited greases is not completely revealed by the bomb oxidation test. It is in bearing performance tests that they stand out. For example, a grease conforming to the requirements of Military Specification MIL-L-3545 (High Temperature Lubricating Grease) showed a pressure drop of about 6 psi during 500 hours at 210° F. A pressure drop of this magnitude is not outstanding as there are greases containing other inhibitors which approach or equal this performance. However, this

[1]U. S. Patents 2,398,414 and 2,398,415.

grease, in the Navy High Speed Bearing Test at 10,000 rpm and 300° F. shows an average life of about 1000 hours. This performance has been confirmed in many industrial high temperature uses, with plain and antifriction bearings, at both high and low speed. While selenium compounds are relatively expensive, nevertheless they remain, in our experience, the most satisfactory means of imparting to lubricating greases high level oxidation stability coupled with satisfactory bearing performance.

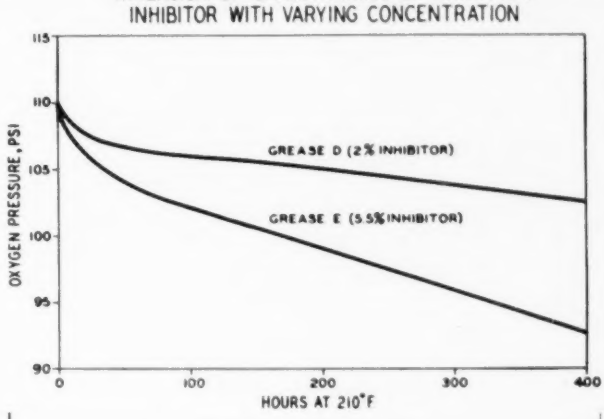
Other oxidation inhibitors that have been found to be effective include the alkyl and aryl amines, phosphites, hydroxy aromatics, and thiazines. The patent literature is rich with many others.

Thin Film Test

A simple, but not rapid, screening test for oxidation resistance is the "Thin Film" Test, in which a thin film of grease is supported on a metal strip—usually steel—and held at an elevated, constant temperature in an oven in an atmosphere of air. In this test greases normally will harden with prolonged exposure, finally becoming brittle and losing bond with the metal surface. The time required to reach this hard and brittle stage is a rough measure of the oxidation resistance of the grease. Some greases on the other hand have been found to liquefy in this test; these were unsatisfactory in service. Consequently such greases can be discarded without further investigation in a bearing, with the realization that on a rare occasion this may mean discarding a potentially useful grease.

Figure 4

INVERSION OF EFFECTIVENESS OF OXIDATION INHIBITOR WITH VARYING CONCENTRATION



A semiquantitative correlation between this test and the Navy High Speed Bearing Test was established for a sodium-base grease and a lithium-base grease, but in general the data are too scattered to generalize. For example, a silica-thickened silicone grease exhibited extraordinary resistance to hardening in this test but failed in a short time in the bearing test. All that can be said is that long life in this test is

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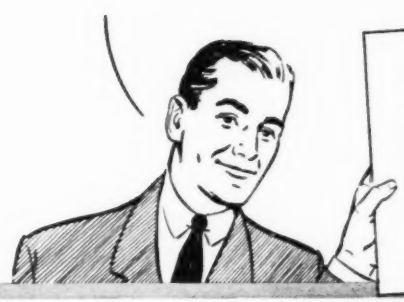

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a necessary but not sufficient criterion of good high temperature bearing performance.

Bearing Tests

As stated earlier, tests of this type do not evaluate oxidation resistance alone; the results are a function of many characteristics, including texture, consistency, and oil separation. Thus only the overall satisfactory character of a grease can be evaluated—and this satisfactory character may often depend on the interaction of two or more additives, each present for a specific purpose. Therefore, we do not propose to discuss this important type of test, even though it is a necessary step in the evaluation of an experimental grease.

Fillers

The retention of an effective film of lubricant is often difficult under many types of operating conditions, examples of which are: shock loading (where E. P. agents are ineffective), such as automotive steel-on-bronze shackle bearings; large rough bearings subject to shock where leakage is excessive, such as lower tumbler bearings of bucket dredgers; slow oscillatory motion bearings, such as the fifth wheels of truck trailers; and the wearing surfaces between the wheel flanges of cars and locomotives and the gauge or inner side of the head of the rails on curves. In all these cases, satisfactory lubrication has been obtained by the addition of a finely divided solid to the lubricating grease. In fact, in many cases the grease itself, that is, the soap-oil system, has assumed the secondary role of a "carrier" and has been modified so as to give maximum performance in all aspects other than lubrication, leaving that function to the filler. The best example of this is the so-called rail and flange lubricant.

For many years there has existed a firm prejudice against fillers on the ground that they cause excessive wear. In an excellent paper before NLGI, C. W. Georgi[5] showed that in antifriction bearings relatively large particles of soft materials or very small particles of hard materials can be present without causing wear greater than that normally experienced with conventional lubricating greases. Thus it would appear that as long as the state of subdivision is closely controlled, the usual objection against fillers can be minimized. One objection, however, to certain fillers is their tendency to "pack" under high pressure. This has been observed with graphite in certain forms.

Many types of material are used as fillers among which are zinc oxide, zinc sulfide, graphite, talc, mica, powdered lead, powdered zinc, gypsum, chalk, lime, asbestos, and molybdenum disulfide.

Coloring Agents

The color and appearance of a grease are important for two reasons. In the first place the grease should be pleasing and appealing to the customer. If he is not satisfied with the looks of the product, he may refuse to buy it and never learn of its excellent performance characteristics. Color and appearance are also important because the customer judges the reproducibility of the product by its looks. If a new container of grease differs perceptibly from previous shipments, the customer may refuse to use it or, if he does use it, he may blame any lubrication difficulties encountered to the new shipment. He has no other way of judging the quality of the grease.

The use of coloring agents is therefore an important part of the development of a new grease. If the natural color of the product is objectionable, consideration should be given to altering the color to make it more pleasing. On the other hand if the natural color is pleasing but is that of the oil-soap mixture itself, it may vary slightly from lot to lot. In that case consideration should also be given to the use of coloring agents, for in this way the color can be controlled and the customer will receive a product of uniform appearance.

Antibleeders

The customer has every right to expect that the grease he purchases will remain stable and not have excessive separation of oil under either storage or operating conditions. Although complete elimination of oil separation may not be desirable, particularly under operating conditions, a frequent phase of the development program for improved greases is the search for additives to reduce oil separation, or "bleeding" as it is commonly called. Among the many materials that have been reported to be antibleeders are metallic salts of naphthenic, oleic, and sulfonic acids, aluminum stearate and other amphoteric metal soaps, high molecular weight alcohols, and acrylic polymers.

The bleeding characteristics of greases are affected, sometimes appreciably, by the nature of the oil stocks and processing conditions. It will be found that some of the above antibleeders are highly effective only in a particular type of grease manufactured according to a definite procedure.

Stringiness Agents

The roller bearings of track-laying type tractors are best lubricated by semifluid-type greases which must be softer than NLGI Grade O in order to flow at the desired rate through the bearings. On reaching the outside of the bearing such a grease will tend to drop off and leave the end of the bearing exposed to the entrance of mud, dust, water, and other possible contaminants. The presence of a stringiness agent, such as polyisobutylene, causes the grease to hold together and form a dam against the entrance of the contaminants and, in this manner, effectively minimize any possible wear.

Stringiness agents are also added to stiffer greases at low concentrations to improve the adhesive properties of the grease, but at these low concentrations the agents serve primarily as sales aids.

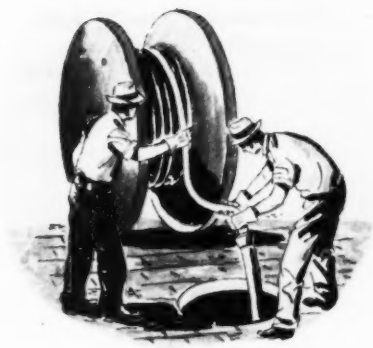
Conclusions

Modern machines, including automobiles, steel mill rolls, high temperature electric motors, and airplanes, are placing increasingly greater demands on lubricating greases. Uncompounded base greases in many cases are unable to meet the demands, but through the use of additives the grease industry is able to maintain pace with the constant improvement of American industry.

[5]The Institute Spokesman, December 1948.

EXPERIENCE PROVES

that greases based on Metasap Aluminum Stearates are superior for tough lubricating jobs



Here are two applications where greases must take the heaviest sort of punishment — and do a first-rate job of lubrication:

1. Lead-covered electric cables, housed in conduits underground, suffer breaks and damaged casings unless efficient lubrication is employed to prevent the generation of excessive friction and heat when these cables are pulled through the piping which holds them.

The problem of producing lubricants able to "stand the gaff" on this job has proved a very difficult one—but it has been solved. One of the nation's leading grease manufacturers, after trying all sorts of greases, is having outstanding success with grease based on a Metasap Aluminum Stearate.

2. Farmers operating along, or near, seacoasts have particular difficulty in protecting their machinery from rust and corrosion during inclement weather—due to salt being carried inland and adding its destructive power to that of moisture and rain.

A second large grease maker, whose name is famous thruout America, has found the way to give farm machinery protection under the worst weather conditions. After testing panels coated with grease based on a Metasap Aluminum Stearate — in humidity and salt spray cabinets, for more than 1,000 hours — he has ascertained that such grease is "head and shoulders above other greases", and that it provides a top-notch protective agent for farm machinery anywhere.

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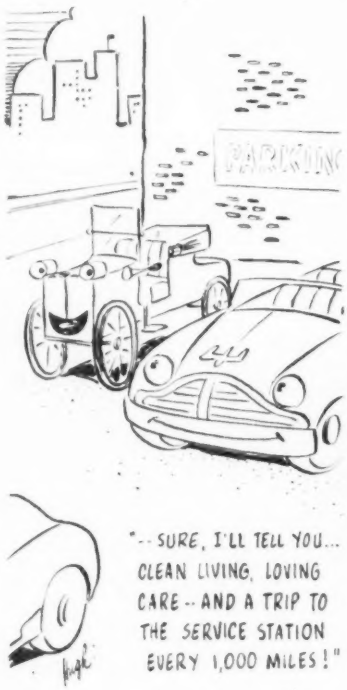

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Patents and Developments

Editor's Note: In "Patents and Developments" (p. 35, Dec. 1952) under Complex Aluminum Soap was listed U. S. Patent 2,599,533 issued to California Research Corporation. The correct patent number is 2,599,553.

Thioether Acid Salt-Containing Greases

Improved lubrication, particularly of antifriction bearings, at abnormally high temperatures is claimed possible by use of a grease containing, as thickeners, the combined soaps of high molecular weight fatty acids and low molecular weight thioether acids. Such a composition, disclosed in the Standard Oil Development Company patent 2,618,598, employs about 3-6% by weight of a salt of general formula R_1SR_2COOH, where R_1 and R_2 are aliphatic hydrocarbon groups or radicals of 1-2 carbon atoms, together with 15-25% of a conventional soap of the C_{12}-C_{24} fatty acids.

Examples of the thioether acids are ethyl thioglycolic acid and ethyl mercaptopriopionic acid. A small amount of the low molecular weight sulfur-bearing aliphatic acid may be combined with acetic acid with the conventional soaps to give a soft, smooth and structurally stable grease.

High Melting Point Calcium Grease of Low Soap Content

Another Standard Oil Development Company patent (2,618,599) discloses that, although the dropping point of calcium greases can be raised by use of low molecular acid salts to the conventional fatty acids, such greases require a relatively large amount of the salt and soap for thickening the lubricating oil to a reasonably firm grease consistency. This not only makes the grease more costly, but also makes it abnormally viscous at room temperature.

The patent points out that such greases can be greatly improved by replacing a part of the conventional fatty acid (stearic or hydroxystearic acid) by a partially dehydrated castor oil or fatty acid derived therefrom before saponification with lime. Thus, a grease containing a combination of three thickening agents (calcium soap of stearic or hydroxystearic acid, calcium soap of dehydrated castor oil, and the calcium salt of a low molecular weight carboxylic aliphatic acid, such as lactic or hydracrylic acids) produces a superior product.

It is interesting to note that the calcium soap of partially dehydrated castor oil, by itself, is insoluble in mineral oil. Yet, in the presence of the other ingredients, it may be readily dispersed at a temperature of 400°-425° F. This insolubility is claimed to be responsible in giving the marked increase in yield. Such greases are claimed to have unusually high dropping points for calcium greases, usually between 350°-450° F. Their resistance to shear is claimed to be very good, and they are said to show excellent resistance against oil bleeding at high temperatures. The preparation of calcium greases showing bleeding of less than 3% of their weight at 225° F. for a product of low soap content is considered an important improvement in the art.

The claims specify 70-95% of mineral base oil, 1-10% calcium soap of stearic or hydroxystearic acid, 1-10% calcium soap of partially dehydrated castor oil having an iodine number between 90-110, and 1-10% of the calcium soap of a hydroxy aliphatic carboxylic acid having not more than 6 carbon atoms.

Composition Having Properties of Gel and Fiber Greases

In the grease-making art, the same ingredients may be used to make both gel and fiber greases. Fiber greases are produced by caustic-saponification of a fat or tallow in the presence of a portion of the lubricating oil, the saponification being carried out at a temperature of the boiling point of the caustic, after which it is raised to 220°-240° F. to vaporize and remove the water. The mass is agitated and additional oil is added during dehydration and cooling to bring the composition to proper proportion of oil and soap.

In producing a gel grease, a neutral soap is heated with oil to a temperature sufficiently above the melting point of the soap so that, with slight stirring, a single liquid phase is produced. This liquid then is cooled quickly to give the grease a gel structure. Such greases are most suitably produced from high viscosity index, low viscosity oils, while fiber greases are generally made from low V.I., high viscosity oils.

According to the Phillips Petroleum Company patent 2,619,461, gel greases having satisfactory lubricating properties can seldom be made with oils having viscosities higher than 500-700 S.U.S., although they are often desirable and needed. The invention is claimed to permit the incorporation of such higher viscosity oil (in the form of a fiber grease) in a gel type grease. Blending a high viscosity oil directly with a gel grease usually produces a fluid mass without grease structure.

The initial step of the process is the production of the two individual type greases. The gel grease is incorporated with stirring into the fiber grease, the temperature being 110°-140° F., the two greases preferably having the same consistency. The final product should contain 20-70% of the gel grease and 8-20% of soap. Such a fibrous-gel grease is claimed to be quite work-stable, retaining its lubricating properties during use.

One feature of the invention involves extraction of a neutral oil with a solvent such as phenol to produce a high V.I. paraffinic fraction and a low V.I. non-paraffinic fraction. The paraffinic fraction is used in making one grease constituent, while the other fraction is used to make another. The two greases then are mixed to produce the fibrous-gel grease.

In many respects the purpose of this patent resembles that of patent No. 2,614,079 discussed in this column last month.

Sulfonate Greases Containing Guanidine Salt

Among the recent patents dealing with sulfonate soap greases, is U. S. Patent 2,620,301 issued to Standard Oil Company (Indiana), whose object is to enable production of stable, thermally-reversible lubricant greases. Mahogany sulfonic acid salts of sodium, potassium, lithium, calcium, barium and strontium are employed, the acids preferably having molecular weights in the range of 350-525.

One specific example of a suitable grease has the following formulation:

Guanidine carbonate	2.2%
Sodium mahogany soap	10.0
Hydrocarbon oil	87.8

Besides petroleum lubricating oil, other suitable vehicles specified are Fischer-Tropsch lubricating oils, dihydroxy thioether esters, such as those disclosed in patent 2,451,895, aliphatic dicarboxylic acid esters, such as those disclosed in patent 2,430,222, silicone polymers and monohydroxy 1, 2-polyoxypropylene aliphatic monoethers, such as those described in patent 2,488,644, etc.

Oil Soluble Titanium Compounds

Polymeric titanium carboxylates (polytitanyl carboxylates) which are oil soluble and claimed to be useful in greases, are described in U. S. Patent 2,621,195 issued to E. I. du Pont de Nemours & Co. It is emphasized that the chemistry of titanium still is not clearly understood and valuable new compounds are constantly being discovered.

The patent deals with the discovery that organic ortho esters of titanium can be reacted with certain organic or carboxylic acids and with regular amounts of water to provide products, such as polytitanyl carboxylates, which are claimed to have valuable surface-active and other properties. In one example, 11.3 lbs. of stearic acid are mixed with 5.6 lbs. of tetraisopropyl titanate and the mixture is heated at 50° C. for 2 hrs. to produce a viscous light brown liquid. This is cooled to room temperature and 0.35 lb. of water is added dropwise with agitation. The resulting liquid then is heated at 50° C. under reduced pressure to strip off excess isopropanol. The residue is allowed to stand overnight, and a light brown waxy solid results which is extracted with acetonitrile to remove unreacted stearic acid. The remaining product is identified as polytitanyl sesquistearate.

There is little further information as to just what value such compounds would have in lubricating greases.

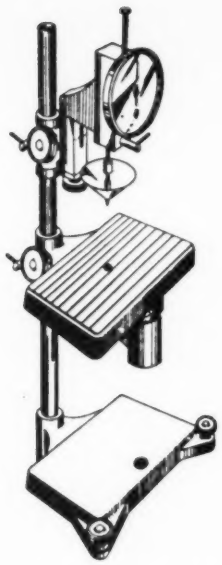
Soaps of Acids from Oxidized Hydrocarbons

A cheap source of acids for the production of greases and other products is the oxidation of hydrocarbons. According to U. S. patent 2,622,092 issued to Socony-Vacuum Oil Company, acids forming highly oil-soluble salts are produced by oxidation of a hydrocarbon fraction containing upwards of 80% by volume of aliphatic and naphthenic hydrocarbons and preferably boiling between 400°-700° F.

The oxidation operation may be carried out by any of the well-known methods. When the oxidized product is saponified, it is cooled and separates into two strata. The bottom aqueous layer is treated with hydrochloric acid to liberate combined acids and the oily layer of insoluble acids thus liberated is dried.

This oily layer is dried and extracted with benzene or petroleum ether. The extract is distilled to remove solvent, and the remaining acids then are converted into soaps in the usual manner.

The acids obtained by oxidation of light white oil (acid-treated kerosene) were in the form of a clear, dark amber-red fluid in 57.3% yield, based on the total acids solvent treated. They had a neutralization number of 211.7, specific gravity of 0.9779, and 150 color (Lovibond).



Tentative Method of Test for Cone Penetration of Lubricating Grease[1]

ASTM Designation: D 217 - 52T

Issued, 1952.[2]

This Tentative Method has been approved by the sponsoring committee and accepted by the Society in accordance with established procedures, for use pending adoption as standard. Suggestions for revisions should be addressed to the Society at 1916 Race St., Philadelphia 3, Pa.

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FIG. 1. PENETROMETER. This figure represents a composite drawing illustrating the two available types of instruments, (1) that with an adjustable table, and (2) that with an adjustable cone assembly. The use of either type instrument is permissible in this test.

Scope

1. (*a*) This method describes three test procedures for the empirical estimation of the consistency of lubricating greases by measurement of the extent of penetration of a standard cone. The method is applicable to a variety of greases since it describes procedures for the measurement of worked penetration, of unworked penetration, and of block penetration. Penetrations up to 400, the practical limit of the cone, may be measured.

Note 1.—The procedure for the measurement of penetration of petrolatum is described in A.S.T.M. Method D 937[3].

(*b*) Unworked penetrations are affected by a number of factors which are difficult to control. They do not generally represent the consistency of greases in use as effectively as do worked penetrations, which should be preferred, wherever practicable, for inspecting lubricating greases.

Note 2.—The unworked penetration of a grease may not be a reliable measure of its consistency in its original state of manufacture. Any transferring or other manipulating of the grease subsequent to manufacture tends to affect the unworked penetration by amounts depending on the type of the grease and the handling it is given.

(*c*) Penetration of block greases can be obtained on those products which are sufficiently hard to hold their shape, generally products having penetrations below 85.

Definitions

2. (*a*) *Penetration* of lubricating grease is the depth, in tenths of a millimeter, that a standard cone penetrates the sample.

(*b*) *Working* is the altering of the penetration of a grease by subjecting it to any form of agitation or shearing action for a significant period.

(*c*) *Worked Penetration* is the penetration of a sample of lubricating grease immediately after it has been brought to 77 F. ± 1 F. and then subjected to 60 strokes in a standard grease worker.

(*d*) *Unworked Penetration* is the penetration at 77 F. of a sample of grease which has received only the minimum handling in transfer from sample can to test apparatus and which has not been subjected to the action of a grease worker.

(*e*) *Block Penetration* is the penetration at 77 F. of a grease which is sufficiently hard to hold its shape.

Outline of Method

3. The penetration is determined at 77 F. using a penetrometer to apply the standard cone to the sample for 5 sec. Worked penetrations are determined immediately after subjecting the sample to 60 strokes in the standard grease worker. Unworked penetrations are determined on the

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[1] Under the standardization procedure of the Society, this method is under the jurisdiction of the A.S.T.M. Committee D-2 on Petroleum Products and Lubricants.

[2] Revised and reverted to tentative by the Society at annual meeting, June, 1952.

Prior to its present publication as tentative this method was published as tentative from 1925 to 1948, being revised in 1926, 1927, 1933, 1938, 1944, and 1947. It was adopted in 1948 and published as standard from 1948 to 1952.

In 1952, the Appendix and Fig. 4 were revised. Revisions provide new specifications for the components of the penetrometer and a test for penetration of lubricating greases worked more than 60 strokes. The method was also reverted to Tentative.

[3] 1952 Book of ASTM Standards, Part 5.

sample as received. Block penetrations are determined on a freshly prepared face of a cube cut from a block of grease with the standard cutter.

Apparatus

4. (*a*) *Penetrometer,* for applying the standard cone to the surface of the sample and for measuring the penetration at the conclusion of the test. The penetrometer shall be constructed in such a manner that, by means of a slow-motion adjustment of either the cone assembly or the table, depending upon the type instrument, the accurate placement of the tip of the cone adjoining the level surface of the sample may be made while maintaining a "zero" reading on the indicator. Determine that the cone falls, when released, without appreciable friction. The instrument shall be provided with leveling screws and a spirit level to maintain the cone shaft in a true vertical position. A simplified sketch of such an instrument with cone attached is shown in Fig. 1.

(*b*) *Cone,* as specified in the Appendix.

(*c*) *Grease Worker,* as specified in the Appendix.

(*d*) *Grease Cutter,* having a sharp, rigidly mounted beveled blade, essentially as specified in the Appendix, for preparing samples for determining block penetration.

(*e*) *Water Bath,* capable of regulation to 77 ± 1 F., and of suitable design for conveniently bringing the assembled worker to the test temperature. If the bath is to be used also for samples for worked penetration, provide means for supporting the containers without danger of water getting onto the exposed sample surfaces, and provide a bath cover to maintain the temperature of the air above the sample at 77 F. An air bath, maintained at 77 ± 1 F., is required for determining block penetration; a tightly sealed container placed in the water bath will suffice.

Note 3.—Alternatively the use of a constant-temperature test-room or an air bath instead of the water bath is permitted.

(*f*) *Spatula,* of corrosion-resistant steel, having a stiff blade 1.25 in. in width and at least 6 in. in length with its end cut on the square.

Procedure for Worked Penetration

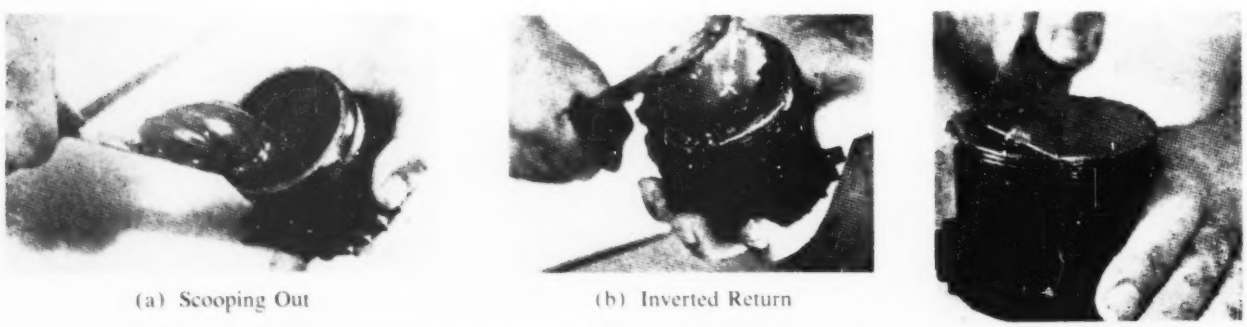
5. (*a*) *Sample.*—Sufficient sample to overfill the cup of the standard grease worker (at least 1 lb.) is required.

(*b*) *Working.*—Transfer sufficient sample to the cup of the clean grease worker to fill it heaping full (mounded up about 0.5 in. at the center), avoiding the occlusion of air by packing with the spatula. Assemble the worker and, with the vent cock open, depress the plunger to the bottom. Insert through the vent cock the dial thermometer so that its tip is in the center of the grease. Place the assembled worker in the water bath maintained at 77 F. (Notes 3 and 4) until the temperature of the worker and contents is 77 ± 1 F. as indicated by the thermometer. Then remove the worker from the bath and wipe off excessive water adhering to its surfaces. Remove the thermometer and close the vent cock. Subject the grease to 60 full double strokes of the plunger, completed in about 1 min., and return the plunger to its top position. Open the vent cock, remove the top and plunger, and return to the cup as much of the grease clinging to the plunger as may readily be removed. As the worked penetration of a lubricating grease may change significantly on standing, the operations described in Paragraphs (*c*), (*d*), (*e*), and (*f*) shall be performed without delay.

Note 4.—If it is desired to immerse the portion of the worker above its closure, take care that the lid is water-tight in order to prevent the entrance of water to the worker.

(*c*) *Preparing Sample for Measurement.* — Prepare the worked sample in the cup for testing so that a uniform and reproducible structure of grease will be obtained. As this part of the procedure is the most difficult to reproduce, the following steps shall be followed in detail: Jar the cup sharply on the bench or floor to fill in the holes left by the plunger (Note 5). Scoop out with the spatula a generous portion of the grease (Fig. 2(*a*)) and return it, inverted, to the cup (Fig. 2(*b*)) so that portions of the grease from the bottom will be brought to the surface, and the irregular portions previously at the surface will be buried in the cup. If the surface still presents an irregular appearance, repeat the operation as required; do not mix the grease any more than necessary and under no condition mix the grease by stirring it in the cup. Alternately, jar the cup sharply on the bench or floor and pack the grease down in the cup with the spatula to remove any air pockets (Note 5). Scrape off the excess grease extending above the rim of the cup by moving the blade of the spatula, held inclined toward the direction of motion at an angle of 45 deg., across the rim of the cup (Fig. 2(*c*)), retaining the portion removed (Note 6).

Note 5.—The jarring should be as vigorous as required to remove the entrapped air without splashing the sample from the cup. In performing these operations, a minimum of manipulation should be used, as any agitation of the grease



(a) Scooping Out (b) Inverted Return (c) Scraping Off

FIG. 2. PREPARING WORKED SAMPLE FOR PENETRATION MEASUREMENT.

may have the effect of increasing the working beyond the specified 60 strokes.

Note 6.—Particularly when testing soft greases, retain the grease removed from the cup in scraping to provide a full cup for subsequent tests. Keep the outside of the rim of the cup clean, so that the grease forced by the penetrometer cone to overflow the cup may be returned to the cup prior to turning the sample for the next test.

(*d*) *Penetration Measurement.* — Place the cup on the penetrometer table, making certain that it cannot teeter during testing. Observe that the cone is in its "zero" position. Adjust either the indicator assembly or the table, depending upon the type instrument, until the tip of the cone nearly touches the surface of the sample at a point close to the center of the container. Securely lock the movable assembly in this position. Then by means of the slow motion adjustment bring the cone tip to just touch the surface of the sample. Watching the shadow of the cone tip is an aid to accurate setting. Operating the release mechanism rapidly, release the cone shaft and hold it free for 5 sec., timing this interval with a stopwatch registering to 0.1 sec. (Note 7). Observe that the release mechanism does not drag on the shaft. Then gently depress the indicator shaft until it is stopped by the cone shaft and read the penetration from the indicator scale.

Note 7.—The timing can be done conveniently by starting the watch before beginning the test, releasing the cone shaft as the second hand crosses a unit graduation on the watch, and engaging the shaft of the cone when the watch indicates exactly 5 sec. later.

(*e*) *Cleaning Cone.*—Following each test, clean the penetrometer cone by wiping it carefully with a clean cloth while holding it securely in its raised position (to avoid bending its shaft). Do not rotate the cone, as this may cause wear on the release mechanism.

(*f*) *Additional Tests.*—Immediately make two more tests in succession on the same sample, returning to the cup the portion previously removed with the spatula and repeat the operations described in Paragraphs (*c*), (*d*), and (*e*). Report the average of the three tests, to the nearest 0.1 mm., as the *worked penetration* of the sample.

Procedure for Unworked Penetration

6. (*a*) *Sample.*

(*1*) *For Greases Having Penetrations of 200 or Less,* three tests are made, properly spaced, on a single portion of grease. Sufficient sample to overfill the cup of the standard grease worker (at least 1 lb.) is required. Preferably, it should be contained in the original package or container for testing, because transfer will work the grease and may change its unworked penetration. For axle grease and similar products, an original container having the inside dimensions of the cup of the standard grease worker *must* be used.

(*2*) *For Greases Having Unworked Penetrations Above 200,* a sample, at least three times the amount needed to fill the cup of the standard grease worker, is required. Preferably, it should be contained in the original package or container for testing, because transfer will work the grease and may change its unworked penetration (Note 8).

Note 8.—When mutually agreed by the interested parties, the test may be performed on the sample in its container as received, or after transfer to a test container by any detailed technique satisfactorily understood by both parties. As it is generally not feasible to obtain a container as received which is at least level full, the transfer of the sample directly to a test container with a minimum of working is preferred. An exception *must* be made, however, in the case of products such as axle greases which change radically in consistency on very slight handling and which *must* therefore be tested in their original containers.

(*b*) *Preparing Sample for Measurement.*—Transfer from the container as received (at room temperature) a portion of the sample, preferably in one lump, to overfill the cup of the grease worker or a metal container of equal inside dimensions (Note 8). Make this transfer in such a manner that the grease will be worked as little as possible. Jar the container to drive out trapped air and pack the grease with the spatula, with as little manipulation as possible, to obtain a cupful without air pockets. Bring the temperature of the sample to 77 ± 1 F. by placing it, immersed to within 1 in. of the rim, in the covered water bath for at least 1 hr. (Note 9). Take care that no water is allowed to get on the surface of the grease. After 1 hr. remove the container from the bath and wipe off excessive water clinging to it. Scrape off the excess grease extending above the rim by moving the blade of the spatula, held inclined toward the direction of motion at an angle of 45 deg., across the rim of the cup (Fig. 2(*c*)). Do not perform any further leveling or smoothing of the surface throughout the determination of unworked penetration.

Note 9.—If the initial sample temperature differs from 77 F. by more than about 15 deg., or if an alternative method of adjusting the sample to 77 F. is used, allow sufficient additional time to assure that the sample is at 77 ± 1 F. before proceeding.

(*c*) *Penetration Measurement.* — Determine the penetration of the sample, as directed in Sections 5 (*d*) and (*e*). If the sample has a penetration of over 200, center the cone carefully in the container, which can then be used for only one test. If the sample has a penetration of 200 or less, perform three tests in a single container, spacing these tests on three radii 120 deg. apart and midway between the center and side of the container so that the cone will neither strike the side of the container nor impinge on the disturbed area made in a previous test.

(*d*) *Additional Testing.*—Make a total of three tests on the sample (either in three containers or in one, as directed above), and report the average value, to the nearest unit, as the *unworked penetration* of the sample.

Procedure for Block Penetration

7. (*a*) *Sample.*—Obtain sufficient sample of the grease, which must be hard enough to hold its shape, to permit cutting from it a 2-in. cube as a test specimen.

(*b*) *Preparing Sample for Measurement.*—By means of the specified grease cutter, cut as a test specimen from the sample at room temperature (Note 9), a cube about 2 in. on an edge (Fig. 3(*a*)). While holding this specimen so that the unbeveled edge of the cutter is toward it (Fig. 3(*b*)),

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slice off a layer about 1/16 in. in thickness from each of three faces adjacent to a single corner, which may be truncated for identification (Fig. 3(*c*) and Note 10). Take care not to touch those portions of the newly exposed faces which are to be used for testing, or to set a prepared face against the base plate or guide of the cutter. Bring the temperature of the finished specimen to 77 ± 1 F. by placing it in a constant-temperature bath maintained at 77 F. for at least 1 hr. (Note 11).

Note 10.—The testing of three faces is intended to equalize in the final value the effect of fiber orientation in testing fibrous greases. Smooth-textured non-fibrous greases may be tested on one face only, when agreed between the interested parties.

Note 11.—If a constant temperature test room maintained at 77 F. is used and the original sample has been in the room long enough to have assumed this temperature, the use of the air bath may be omitted.

(*c*) *Penetration Measurement.*—Place the test specimen on the penetrometer table with one of the prepared faces upward, and press it down by the corners to make it rest level and firmly on the table so that it cannot teeter during the test. With the utmost precision and with the cone in its "zero" position adjust either the indicator assembly or table, depending upon the type instrument, until the tip of the penetrometer cone just touches the test surface. Determine the penetration as directed in Section 5(*d*) and (*e*). Make a total of three tests on the exposed face of the specimen, locating the tests at least ¾ in. from the edge and as far apart as possible without impinging on any touched portion, air hole, or other apparent flaw in the surface. If the result of any of these tests differs from the others by more than three units, make additional tests until three values agreeing within three units are obtained. Average these three values for the face being tested.

(*d*) *Additional Tests.*—Repeat the procedure described in Paragraph (*c*) on each of the other prepared faces of the specimen. Report one-third of the sum of the averages for the three faces, to the nearest unit, as the *block penetration* of the grease under test.

Precision

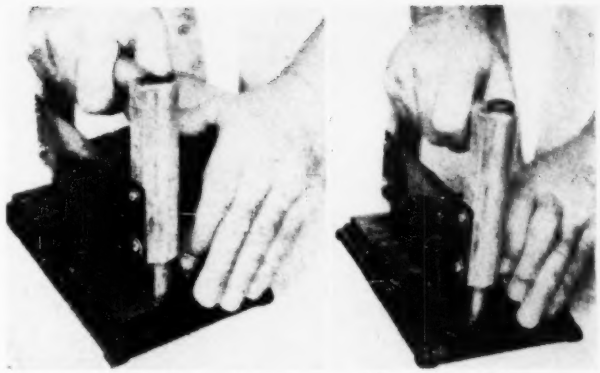
8. Results should not differ from the mean by more than the following amounts:

	Repeatability, One operator and Apparatus	Reproducibility, Different Operators and Apparatus
Worked Penetration	5 units	10 units
Unworked Penetration	5 units	15 units
Block Penetration	2 units	5 units

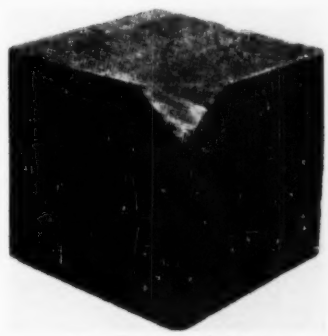
Appendix

APPARATUS

A1. *Cone:* Consisting of a conical body of brass or corrosion-resistant steel with detachable hardened steel tip, shall be constructed to conform to the tolerances shown in Fig. 4. The total weight of the cone shall be 102.5 ± 0.05 g and that of its movable attachments shall be 47.5 ± 0.05 g; the attachments consist of a rigid shaft having a "step" at its upper end and suitable means at its lower end for engaging the cone. The interior construction may be modified to achieve the specified weight, provided that the general contour and weight distribution is not altered. Polish the outer surface to a very smooth finish.



(a) Cutting Test Specimen (b) Slicing Off Layer



(c) Truncated Corner for Identification

FIG. 3.

PREPARING BLOCK SAMPLE FOR PENETRATION MEASUREMENT

A2. *Grease Worker* shall conform to the dimensions given in Fig. 5, but the dimensions not shown may be altered and other methods of fastening the lid and securing the worker may be used. The worker may be constructed for either manual or mechanical operation, provided a rate of 60 ± 10 strokes per min. can be maintained. A removable bimetallic dial thermometer, graduated in degrees, and standardized at 77 F., shall be provided for insertion through the vent cock.

A3. *Grease Cutter:* Having a sharp, rigidly mounted beveled blade, shall be essentially as shown in Fig. 6. It is necessary that the blade be straight and sharpened as shown.

A4. *Procedure.*—To obtain information on the penetrations of greases after being worked for more than 60 strokes, proceed as follows:

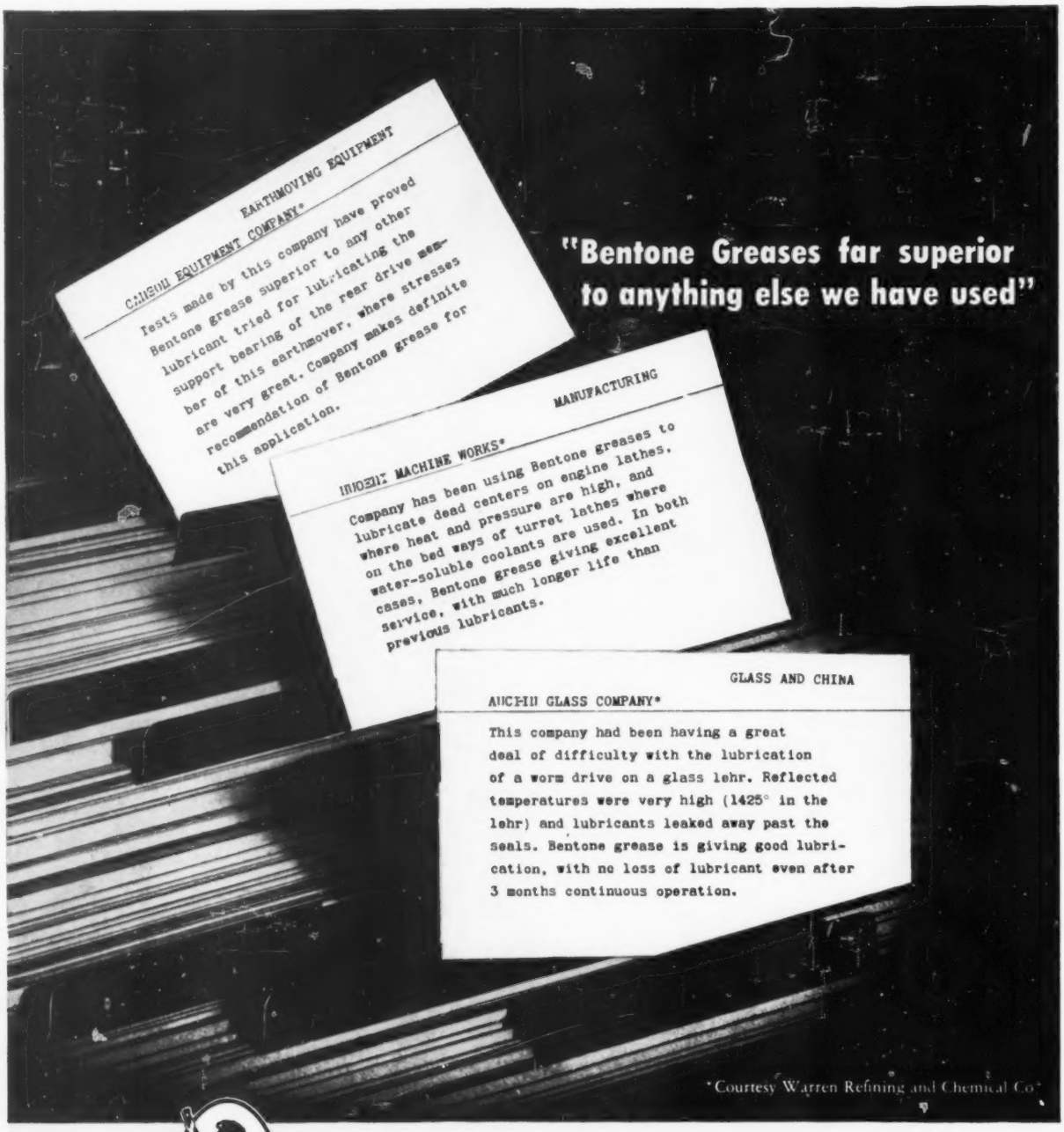
(*a*) Fill the cup and adjust to 77 ± 1 F., as directed in Section 5. Work for 60 strokes and, if desired, determine the penetration as directed in Section 5 (*d*).

(*b*) Using the same cup of grease, perform the desired additional working, observing the following deviations:

(*1*) Operate the worker mechanically.

(*2*) Perform the working in a constant-temperature room or air chamber maintained at 77 ± 1 F.

(*3*) Upon completing the additional working, open the petcock and determine the temperature of the grease with the dial thermometer.


EARTHMOVING EQUIPMENT
Tests made by this company have proved Bentone grease superior to any other lubricant tried for lubricating the support bearing of the rear drive member of this earthmover, where stresses are very great. Company makes definite recommendation of Bentone grease for this application.
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Company has been using Bentone greases to lubricate dead centers on engine lathes, where heat and pressure are high, and on the bed ways of turret lathes where water-soluble coolants are used. In both cases, Bentone grease giving excellent service, with much longer life than previous lubricants.
GLASS AND CHINA
This company had been having a great deal of difficulty with the lubrication of a worm drive on a glass lehr. Reflected temperatures were very high (1425° in the lehr) and lubricants leaked away past the seals. Bentone grease is giving good lubrication, with no loss of lubricant even after 3 months continuous operation.
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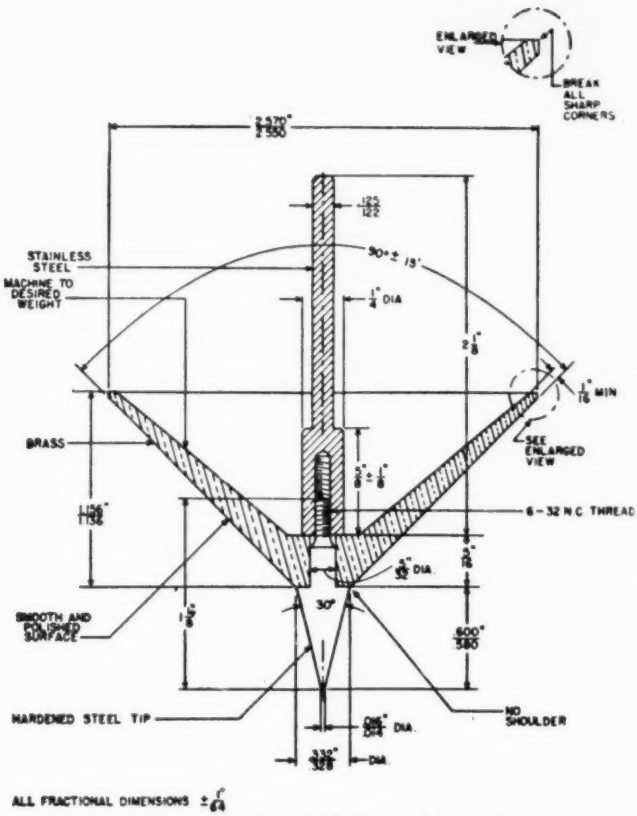

Note.—Total weight of the cone shall be 102.5 ± .05g. and of its movable attachments shall be 47.5 ± .05g.

FIG. 4. PENETROMETER CONE

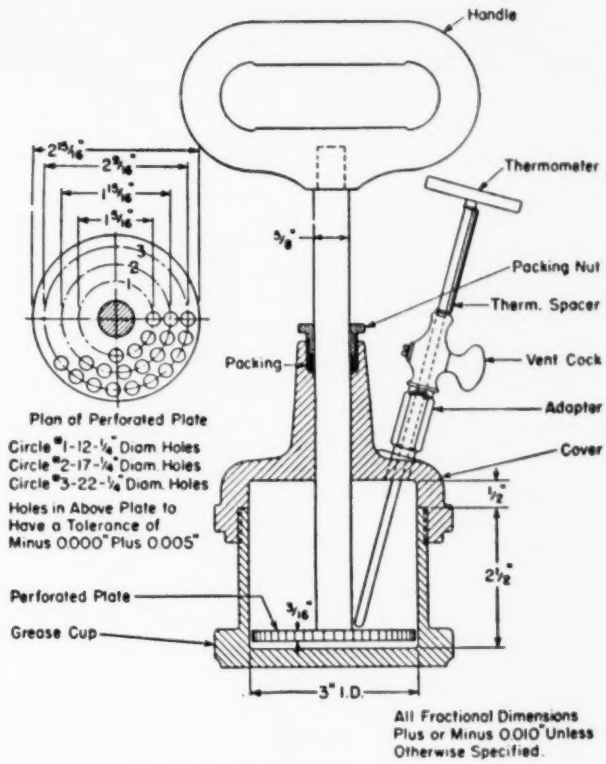

FIG. 5. GREASE WORKER

(4) Prepare the sample, and immediately determine the penetration, as directed in Section 5 (*c*) and (*d*).

(*c*) Place the cup and contents in a water bath maintained at 77 ± 1 F., with the water level coinciding with the lower limit of the threaded portion of the cup. At each 5-min. interval thereafter, proceed as follows:

(*1*) Scoop out with the spatula a generous portion of the grease and return it, inverted, to the cup, so that portions of the grease from the bottom will be brought to the surface, and the portions previously at the surface will be buried in the cup. Note the temperature of the grease at each 5-min. period and, as soon as the temperature has attained 77 ± 1 F., proceed as directed in Item (*2*).

(*2*) Immediately work the sample of grease for 60 strokes and determine the penetration as directed above, beginning with the fifth sentence of Section 5 (*b*), and continuing through Section 5 (*d*).

(*d*) Report the following for each degree of working:

(*1*) Total number of strokes,

(*2*) Temperature immediately after working,

(*3*) Penetration immediately after working, and

(*4*) Penetration after cooling to 77 F. and working 60 additional strokes.

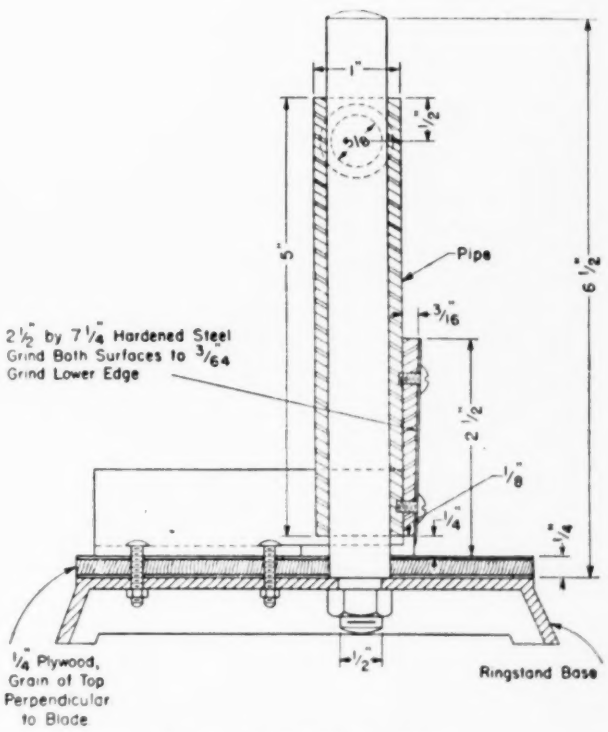
Pipe
2 1/2" by 7 1/4" Hardened Steel
Grind Both Surfaces to 3/64
Grind Lower Edge
1/4" Plywood, Grain of Top Perpendicular to Blade
Ringstand Base

FIG. 6. GREASE CUTTER

Inter-state Plans to Move Into New Plant by June 1; Changes In Company Officials Announced Recently

HOLLIS D. IMMICK

THE Inter-State Oil Co., regretfully announces the death of its president, immediately as the result of an automobile accident close to Kansas City, Missouri.

Born in Kansas City, Missouri, he attended the University of Missouri and was a graduate of Kansas City Junior College. Active in the petroleum industry, he was a charter member and director of the Independent Oil Compounders Association, and a member of the Oil Men's Club of Kansas City, Society of Automotive Engineers, and the National Lubricating Grease Institute.

The Company is believed to be the oldest independent compounding and marketing company west of the Mississippi River. It was founded in 1887 by Mr. Shepard's father. In 1951 disaster struck the company plant in Kansas City, Kansas, when the highest flood ever known to the community engulfed the building and covered it with 28 feet of water, completely destroying the building and all facilities. Since then, the company has been operating in temporary quarters at 2005 Armour Road, North Kansas City, Missouri.

Hollis D. Immick Becomes President

Succeeding Mr. Shepard as president will be Hollis D. Immick, who has been with the company as vice-president since 1947, and a director since 1940. In addition to his intimate knowledge of company affairs, Mr. Immick is well qualified for the position. He has a civil engineering degree from Yale and is a registered professional engineer. Prior to joining the Inter-State Oil Co. organization, he was president of the Immick Company, a general contracting organization.

Robert A. Nylander has just been announced as the new company treasurer. He has been its office manager and purchasing agent for a number of years and is intimately acquainted with both company affairs and the industry.

A new appointment as company secretary, Mr. Shepard's widow, has been announced. Mrs. Shepard is well acquainted with company details and operations, having been actively connected with the organization through her husband for a number of years.

Immediately following the disastrous destruction of the company plant by the flood in 1951, the company has been actively engaged in constructing a new plant at 250 South Fifth Trafficway in Kansas City, Kansas.

The new plant will be completely out of all future flood danger, and is being erected at an estimated cost of $225,000. It is located on a 10-acre tract, and is expected to double previous production.

The company has announced its intention to be in its new plant by June 1 with completely new equipment and expanded facilities for serving its lube oil and grease customers. A complete line of lubrication application accessories will continue to be carried and sold by the company.

INTER-STATE OIL CO.'s NEW PLANT, located at 250 South Fifth Trafficway, Kansas City, Kansas, is expected to be occupied by June 1. The company's former facilities were destroyed in the 1951 flood disaster.

NEW MEMBER

Newridge Chemical Co. Joins

The New Associate Member Names Thomas E. Shine as Its Company Representative in NLGI. Shine Is President of the Company Formed in 1945 at Chicago.

THOMAS E. SHINE

Thomas E. Shine graduated from the University of Cincinnati in Chemical Engineering in 1932. For the next seven years he was associated with Emery Industries, Inc., in research and sales work.

For the next six years he was with the W. C. Hardesty Co., also in research and development, and sales activities. Newridge Chemical Co., was formed in 1945 and he became, and still is, president of this company. He is a member of the American Oil Chemists Society, American Chemical Society and the American Association of Textile Chemists and Colorists.

Newridge Chemical Co., is engaged in the hydrogenation of all types of inedible animal, vegetable and marine fats. All of this hydrogenation work is on a "tailor-made"basis. They claim it is possible for them to carry out special fat hydrogenation that would not be practical for some of the larger operators in this field. They can obtain a very high degree of se'ectivity in their hydrogenation of fat which, of course, means that they can eliminate only the poly-unsaturated portions of the fat resulting in unusual stability characteristics. This question of stability is of utmost importance in lubricating grease manufacture.

The majority of this fat hydrogenation is conducted on a "toll basis" for soap and fatty acid manufacturers. Rubber Reserve has specifications requiring that all fat entering into the manufacture of soap, for synthetic rubber production, must be partially hydrogenated. A considerable portion of our hydrogenation capacity is devoted to this type of selective hydrogenation. On this "tailor-made" basis the only limitations on the finished hydrogenated or partially hydrogenated product are the inherent limiting characteristics of the starting fat. Since this starting fat can be varied over quite a range of chemical composition, practically any type of hydrogenated fat can be obtained.

Newridge Chemical Co., is also engaged in the manufacture of emulsifying bases for blending water soluble metal working compounds, such as, cutting oils, grinding oils, and drawing compounds. We do not manufacture the finished metal working compounds but supply the emulsifying bases to the manufacturers of such products.

The company also has available petroleum sulfonates of all kinds and types. These cover a wide range of molecular weight, solubility, degree of purity, concentration, etc.

Also manufactured are heavy metal sulfonates, such as, barium and calcium sulfonates. These heavy metal soaps are offered either as the basic or neutral material in varying concentrations. These soaps have widespread acceptance and use in the lubricant additive field.

The company manufactures numerous types of textile oils and sizing materials. These textile oils are primarily water soluble oils and are used in practically every stage and phase of textile manufacture. The advent of some of the newer textile fibers presented new and unusual sizing problems and Newridge has sizing materials that have proved very satisfactory for these newer fibers.

From the foregoing, it is obvious that the term "chemical specialties" aptly describes the activities of Newridge Chemical Co. Fortunately, most of NLGI representatives are usually concerned with the metal working compounds manufactured by their companies, in addition to their primary interest in lubricating grease manufacture. Because of this fact, Newridge Chemical Co. feels there is a dual advantage to its membership in this organization.

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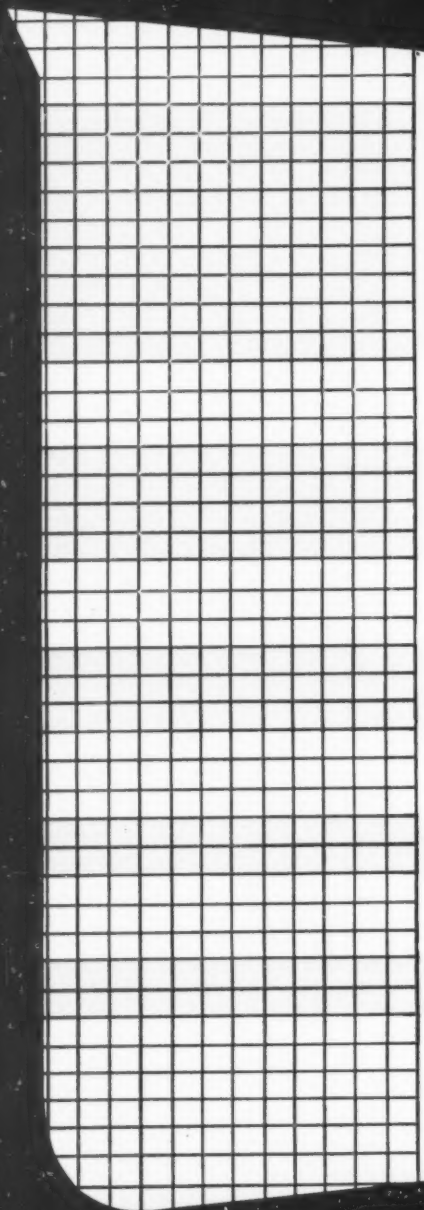

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PEOPLE in the Industry

Martin Goland Reappointed To NACA Technical Committee

Martin Goland, associate director for engineering at Midwest Research Institute, has been re-appointed a member of the committee on aircraft construction., a technical group of the National Advisory Committee for Aeronautics, it has been announced. Mr. Goland will also serve another term as chairman of the subcommittee on vibration and flutter, an auxiliary department of the national organization, specializing in the study of vibration in aerodynamic bodies.

Appointments to the NACA's technical committees are based on recognized leadership in a special field. Selections include engineers from industry, research, education, and civil and military agencies of the government. Mr. Goland is widely known in the field of engineering mechanics, and in addition to his post at Midwest, is currently serving as a regional counselor for the Office of Ordnance Research. He is also editor of *Applied Mechanics Reviews*, internationally circulated publication for engineers.

Among important functions of the committee is the coordination of research programs conducted by the NACA and other agencies. This group also provides material assistance in the consideration of problems related to assigned technological areas, in reviewing research in progress at NACA laboratories and other organizations, and in recommendation of new research work.

Busch Elected Secretary Of Stewart-Warner Corp.

Alfred H. Busch was elected secretary of Stewart-Warner Corporation by members of the board of directors during their regular meeting held in March, James S. Knowlson, president and board chairman, announced. Mr. Busch has been "acting secretary" since the death of James I. Minteer on February 24.

Mr. Busch joined Stewart-Warner as an attorney in the legal and industrial relations department in June 1947.

A native of Chicago, Mr. Busch graduated from Lane Technical high school in 1937 and the University of Wisconsin in1942. He attended the University of Wisconsin law school and graduated from the law school of De Paul University in 1947. He was admitted to the Illinois Bar the same year. He serves as chairman of the board of managers, Uhlich Children's Home, Chicago, and is a veteran of four years in the army, two of them overseas.

Foote Mineral Elects John S. Gates Treasurer; Other Personnel Changes Announced

Foote Mineral Company announces the election of John S. Gates as treasurer, succeeding Gordon H. Chambers who continues as president.

Mr. Gates, a resident of Chestnut Hill, Penn., resigned as secretary and assistant treasurer of the Lehigh Coal and Navigation Company to accept the top financial position at Foote, effective March 1st.

James E. Castle recently joined Foote Mineral Company as manager of the Lithium Mining and Milling Division at Kings Mountain, North Carolina.

Ernest A. Remesch recently joined Foote Mineral Company as superintendent of the new lithium processing plant at Sunbright, Virginia.

A graduate of Montana State College in 1940 with a B.S. in Industrial Engineering, Mr. Gates brings to Foote a wide background of industrial and financial experience, gained from a succession of responsible positions with Westinghouse Electric Corporation, the United States Army (Lt. Colonel), the Scott Paper Company and the Lehigh Coal and Navigation Company.

Mr. Gates is a member of the American Association of Corporate Secretaries, the American Management Association, the National Industrial Conference Board as well as the Philadelphia Cricket Club, the Raquet Club and others.

Mr. Castle is a graduate of Massachusetts Institute of Technology, the Colorado School of Mines, and a member of A.I.M.E. With a background as a mine and mill foreman at various locations in the West and abroad, he became a mining engineer with American Rutile Corporation, Roseland, Virginia, in 1940. From 1943 until joining Foote he was assistant plant manager of the Balmat Mill for St. Joseph Lead Company with responsibilities of operations, cost control, personnel relations and engineering.

JOHN S. GATES

Mr. Castle brings to Foote a substantial knowledge of mining and milling operations for the program of expansion at Kings Mountain.

A graduate chemist from Ohio State, Mr. Remesch joined E. I. du Pont de Nemours in 1934 in the Grasselli Division. During the next 16 years, he held industrial engineering, chemical engineering and production supervisory positions in several Du Pont plants throughout the country. Before joining Foote, he was plant engineer and, more recently, assistant plant manager of the Melson Fertilizer Company, Georgetown, Delaware.

In addition to membership in the American Chemical Society, Mr. Remesch is also a member of Alpha Chi Sigma, Phi Lambda Upsilon and Sigma Xi.

Industry NEWS

July 1 Is Deadline For Aries Book Award Entries

A number of manuscripts on subjects that vary widely from "The Progress of the Canadian Chemical Industry through The Development of the American Petro-Chemical Industry", to "A Case Study on the Development of a New Insecticide", already have been submitted for the first annual book award of R. S. Aries & Associates, to be presented in September 1953 for the first and second best books in the field of economics of the chemical process industries, it was announced by Dr. Robert S. Aries, president of the New York consulting firm of chemical engineers and economists.

The purpose of the Aries Book Award is to encourage chemists, chemical engineers, economists and chemical executives who are experts on economic aspects of the industry to put their knowledge in print.

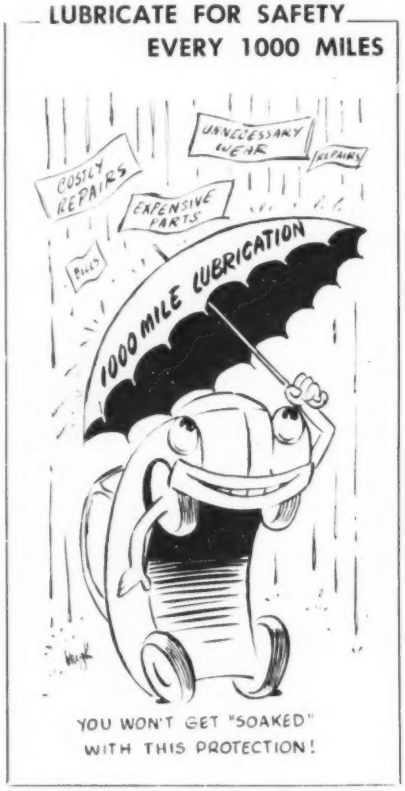
The prizes will be gold and silver statuettes symbolic of chemical economics. Advance royalties of $1500 will be paid to the winner of the first award, and of $500 to the winner of the second award at the time when these awards are made. The first presentation will be in September 1953, and entries may be submitted through July 1, 1953.

The winning manuscripts will be published by Chemonomics, Inc., an affiliate of R. S. Aries & Associates. In order to be eligible, a book must have a minimum length of 20,000 words and must be written especially for the contest. Chemonomics may publish manuscripts which did not win awards—on standard royalty terms—if author and publisher agree. Each manuscript must be accompanied by an entry form which may be had upon request from Chemonomics, 400 Madison Ave., New York 17, N. Y. Manuscripts should be addressed to the publisher, and authors should retain carbon copies.

Aries announces that the judges will be headed by Prof. David D. B. Hertz of Columbia University, and Prof. John Happel of New York University. If, in the opinion of the judges, no manuscripts are found suitable, awards will be withheld.

API Appoints Subcommittees To Study Continuation Of Jobber Franchises

Appointment of three special subcommittees to study problems surrounding continuation of jobber franchises, accounting methods and selection of service station sites has been announced by



J. E. Dyer, chairman of the Jobber Advisory Subcommittee of the American Petroleum Institute.

Members of the jobber franchise subcommittee are: J. G. Jordan, Shell Oil Co., New York, chairman; Charles H. Arnold, Haggert's Service, Inc., Fargo, N. D.; John Harper, Harper Oil Co., Long Island City, N. Y.; Walter Hochuli, The Texas Company, New York; Jess Knowles, Skelly Oil Company, Kansas City, Mo.; R. W. McDowell, Mid-Continent Petroleum Corp., Tulsa, Okla., and George L. Savory, Savory Oil Company, Binghamton, N. Y.

This committee was instructed to see what could be done to help jobbers make adequate preparation for the perpetuation of their businesses in the event of death or incapacity. Mr. Dyer pointed out that many jobber businesses have "folded" because of this lack of foresight and planning by the individuals.

Members of the accounting subcommittee are H. E. Davenport, G. W. Pickering Co., Salem, Mass.; R. C. Arnold, Haggert's Service, Inc., Fargo, N. D.; R. J. Hull, Cities Service Petroleum Company, New York; Robert A. Kent, Kent Oil Company, Salina, Kans., and John H. White, Hewitt Oil Company, Charleston, S. C.

Mr. Dyer told this subcommittee to review the problem of accounting methods for jobbers and distributors, and to examine a manual which has just been completed by the API's financial and accounting committee.

Members of the subcommittee on "Selection of Service Station Sites & Construction Suggestions" are: Dwight F. Benton, Standard Oil Company (Indiana), Chicago; A. M. Hughes, Phillips Petroleum Company, Bartlesville, Okla.; Miles Mills, Oils, Inc., Des Moines, Ia.; Roy Thompson, Apex Motor Fuel Company, Chicago; L. E. Ulrope, Esso Standard Oil Company, New York, and Russel (cq) S. Williams, Gasteria, Inc., Indianapolis, Ind.

In his letter to the subcommittee members, Mr. Dyer said it would be their duty to consider the general subject of service station sites, point up the problem and reach conclusions as to what, if any, action should be taken by any of the arms of the American Petroleum Institute. He noted that the subject has received much study already by other sources.

All three subcommittees were urged to have reports and or recommendations, if possible, for the mid-year meeting of the Division of Marketing in Dallas, May 4 and 5.

Gasoline and other motor vehicle taxes were the biggest money raisers for most of the states in fiscal 1952, totaling 28.5% of all state tax revenue.

IMPROVED LUBRICANTS

Discovery of an unusual chemical phenomenon, which makes possible longer lasting lubricants, is described in a Government research report now available from the Office of Technical Services of the U. S. Department of Commerce.

A big factor in the deterioration of lubricants is the self-oxidation process. This is a chemical reaction in which the oxygen contained in one ingredient of the lubricating composition reacts with other ingredients, producing chemical changes which destroy the composition's lubricating properties.

Heat intensifies the self-oxidation process, hence it is difficult to prepare lubricating compositions which stand up under long storage in warm places, and which withstand high operating temperatures, according to the report.

Furthermore, certain ingredients of lubricating compositions accelerate the self-oxidation process. These are called "pro-oxidants." Certain other ingredients slow up (inhibit) the self-oxidation process. These are called "anti-oxidants."

Scientists at the Naval Research Laboratory who conducted the research found that certain lubricating compositions, which had large amounts of both a certain type of pro-oxidant and a certain type of anti-oxidant, stood up well against deterioration by heat. Investigating the cause of this they found that, when certain anti-oxidants are present by themselves in a lubricating composition, their inhibiting effect on the self-oxidation process is very weak. But when certain pro-oxidants are also present, the inhibiting effect of the anti-oxidants, which should consequently be decreased, instead becomes very strong.

The scientists point out that the pro-oxidants in this case are lithium soaps, which are added to lubricating compositions to give them good lubricating properties at low temperatures, under high gear pressures, etc. And the anti-oxidants which have this peculiar effect are certain types of organic compounds of silicon (such as the aromatic silicones) which are added to give the lubricating composition other desired properties such as proper viscosity, boiling point, etc. Hence the combination of these particular pro-oxidant and anti-oxidant ingredients produces lubricating compositions which not only have desirable all-around lubricating properties, but which also have very strong self-oxidation inhibiting effect, and will therefore stand up long in warm storage and under high temperature operation. "Therefore," the report concludes, various special application lubricants, such as "greases, detergents, oils, diesel lubricants, anti-corrosion oils, turbine oils and extreme pressure gear oils — can now be made which have both longer shelf life and longer operating life."

The report also describes the experimental work which led to this discovery, and presents a theoretical explanation of the chemical reactions which cause these anti-oxidants to have intensified self-oxidation inhibiting effect when mixed with certain pro-oxidants.

PB 111031, *Polyorganoxiloxanes, Organosilanes, and Orthosilicate Esters As Antioxidants.* 19 pages. Mimeo $.50. Orders should be addressed to the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. Enclose check or money order payable to the Treasurer of the United States.

Lincoln Engineering Markets Giant-Size, Lever Type Guns

Lincoln Engineering Company, manufacturer of lubricating equipment, St. Louis, Missouri, has designed and is marketing four new giant-size, lever-type grease guns.

It is claimed they will hold 40 to 100 per cent more lubricant than ordinary grease guns.

The manufacturer states that just a few shots of grease lubricates most bearings . . . no stopping to refill guns . . . no hose to drag, tangle, or get in the way. Guns can be refilled in seconds from a Lincoln filler pump . . . no mess or waste. Guns may also be filled by suction.

Four models are available: Two 21 oz. capacity guns developing 10,000 lbs. pressure; a 32 oz. capacity gun—10,000 lbs. pressure; and a 32 oz. capacity volume-type gun, developing 4300 lbs. pressure. All models include long hydraulic coupler extension for ease in contacting hard-to-reach fittings, and filler nipple for refilling guns from a filler pump. One 21 oz. model is finished in gun metal blue lacquer; the other three are nickle plated. For complete details write Lincoln Engineering Company, Natural Bridge Avenue, St. Louis 20, Missouri, for Bulletin 718.

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Calculator Introduced By Precision Scientific

Precision Scientific Company offers the Induction Period Calculator, a simple device designed to eliminate human errors of interpretation in the ASTM test for Oxidation Stability of Gasoline (D-525). Tested for eight years in the Du Pont laboratories where it was developed, this calculator has proved more than adequate for its purpose: to provide petroleum laboratories with a fast, accurate, reproducible means of calculating the induction period of gasoline.

The calculator consists of two parts: a durable, white, laminated plastic disk, 15 inches in diameter, and a heavy bakelite template. The template fits over a brass hub which aids in centering the Foxboro or "Tag" type pressure charts. Calibrations on the plastic disk are protected by a transparent top layer of plastic so that they cannot rub off with wear.

Only two essential steps are necessary to "read" a test chart:

1. Place Foxboro or "Tag" test chart on disk and "zero" with aid of template.
2. Determine break point with template, at the same time reading Induction Period to estimated one minute accuracy.

Petroleum laboratories will find the calculator combines speed and ease of operation, with an accuracy and reproducibility unattainable by older visual methods of calculation.

Precision Scientific Company
3737 West Cortland Street
Chicago 47, Illinois

Continental Can Presents 'The Story of Packaging'

The development of packaging from early American days to the present is depicted by Continental Can Company in a 15-minute color film entitled, "The Story of Packaging."

From the opening sequence the Mayflower landing at Plymouth Rock, the film, in colorful animation, carries the audience through three centuries of industrial progress. The role played by all types of packaging in the growth of our mass distribution system is portrayed from the original cracker barrel to the streamlined, colorful and sanitary packaging of today.

"The Story of Packaging" places the spotlight on mass distribution and shows how various methods of packaging enable the purchase of ever-fresh goods in convenient amounts and make possible a vast variety of goods to meet every material need. The modern package, possibly more than any other thing, symbolizes our high American standard of living under the free enterprise system.

The film presently is being shown in Continental Can Company plant cities before employees, and local civic, service, and school groups. A program currently is being worked out for wider distribution following the plant-city distribution.

Paint Driers Warehoused In Kansas City by Witco

Witco Chemical Company announces that it is now warehousing a complete inventory of Witco paint driers in Kansas City, Missouri. Same day delivery of all material is assured on telephone orders placed before 11:00 a. m.

Address for mail and telephone orders is: Witco Chemical Company, Crooks Terminal Warehouse, Inc., Broker's Building, Kansas City, Missouri.

Sales Changes Made At Emery Industries

Among recent changes in Emery's Chemical Sales Staff is the shift of J. P. Clancy from the southern area to New England. He will join J. M. Washburn in the responsibility for sales of all Emery products, including fatty acids and derivatives in the New England area.

C. T. Burgess will take over the sales duties vacated by Mr. Clancy, which involves the states of Mississippi, Alabama, Georgia and the eastern section of Tennessee.

Two additional men, E. L. Spencer and E. W. Sack, were appointed to the sales staff. Mr. Spencer, a chemical engineering graduate of Princeton University, was formerly associated with the Cincinnati Chemical Works. Mr. Sack was transferred from Emery's Production Department where he has served as a department supervisor for the past 11 years.

Both will assume field sales responsibility in the near future.

Miller Resumes Duties As OIIC Executive Director

Rear Admiral H. B. Miller (U.S.N., Ret.) has resumed his duties as executive director of the Oil Industry Information Committee, and director of the Department of Information of the American Petroleum Institute.

He had been on leave-of-absence for one year to serve as president of the National Committee for a Free Europe—an American organization dedicated to the fight against Communism and the liberation of freedom-loving peoples from Soviet enslavement.

Admiral Miller completed his tour of duty with the national committee February 28. Concurrent with his return to the Oil Industry Information Committee, Edwin W. Esmay, who had served as acting director during Admiral Miller's absence, went back to his regular position with Standard Oil Company (New Jersey).

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Iodine Number	**1.0 Max.**
Saponification Number	205 to 210
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Specific Gravity @ 100/25°C	0.834
Color	Pure white

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FUTURE MEETINGS of the Industry

APRIL, 1953

15-17 National Petroleum Association (semi-annual meeting), Hotel Cleveland, Cleveland, Ohio.

16-19 National Tank Truck Carriers Inc., Boca Raton Hotel, Boca Raton, Fla.

20 Socy. of Automotive Engineers (aeronautic production forum), McAlpin and Governor Clinton Hotels, New York, N. Y.

20-22 American Petroleum Institute (Division of Transportation, products pipeline conference), Hotel Muehlebach, Kansas City, Mo.

21-22 Michigan Petroleum Assn. (spring meeting), Detroit-Leland Hotel, Detroit, Michigan.

22-24 American Assn. of Petroleum Geologists (Rocky Mountain section meetings), Casper, Wyoming.

24 Inspection Trip — Arnold Engineering Development Center — Tullahoma, Tenn.

26-29 American Inst. of Chemical Engineers (joint meeting with Chemical Institute of Canada), Royal York Hotel, Toronto, Canada.

27 API Safety and Fire-Protection Committees, 6th mid-year conference, Galvez Hotel, Galveston, Texas.

27-28 Independent Petroleum Assn. of America (midyear meeting), Jefferson Hotel, St. Louis, Mo.

27-May 1 American Petroleum Institute (Safety and Fire Protection Committees, midyear meeting), Galvez Hotel, Galveston, Texas.

29-30 American Petroleum Institute (Board of Directors and Executive Committee, combined meeting), Texas Hotel, Fort Worth, Texas.

30-May 1 American Gas Assn. (transmission and storage conference), Edgewater Beach Hotel, Chicago, Ill.

MAY, 1953

3-5 American Petroleum Institute (Division of Marketing, spring meeting), Baker Hotel, Dallas, Tex.

4-5 American Petroleum Institute (Division of Marketing, midyear meeting), Baker Hotel, Dallas, Texas.

4-6 American Oil Chemists' Socy. (44th annual meeting), Roosevelt Hotel, Chicago, Ill.

7-8 American Petroleum Institute (Division of Production, Rocky Mountain District spring meeting), Gladstone Hotel, Casper, Wyo.

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FUTURE MEETINGS of The Industry

MAY, 1953

10-12 Pennsylvania Petroleum Assn. Inc. (3-day meeting), Bedford Springs Hotel, Bedford Springs, Pa.

11-13 American Petroleum Institute (Division of Marketing, Lubrication Committee meeting), Greenbrier Hotel, White Sulphur Springs, West Va.

11-14 American Petroleum Institute (Division of Refining, 18th midyear meeting), Hotel Commodore, New York, N. Y.

14-23 International Petroleum Exposition, Tulsa, Okla.

17-19 Empire State Petroleum Assn., The Roosevelt, New York, N. Y.

18-19 American Petroleum Institute (Committee on Agriculture, annual field trip), Iowa State College, Ames, Iowa.

18-21 Oil Industry Information Committee, Ambassador Hotel, Los Angeles, Calif.

18-22 National Fire Protection Assn. (annual meeting), Palmer House, Chicago, Ill.

22 Virginia Oilmen's Assn. (annual convention), John Marshall Hotel, Richmond, Va.

25-29 American Socy. of Mechanical Engineers (annual conference and exhibit, oil and gas power division), Schroeder Hotel, Milwaukee, Wis.

28-29 Western Petroleum Refiners Assn. (regional meeting), Broadview Hotel, Wichita, Kans.

JUNE, 1953

2-3 American Petroleum Institute (Division of Production, Pacific Coast District spring meeting), Hotel Statler, Los Angeles, Calif.

4-5 Kentucky Oil & Gas Assn. (annual meeting), Lafayette Hotel, Lexington, Ky.

7-12 Socy. of Automotive Engineers (summer meeting), The Ambassador and Ritz-Carlton, Atlantic City, N. J.

15-19 American Petroleum Institute (Division of Production, midyear committee conference), Hotel William Penn, Pittsburgh, Pa.

18-19 Pennsylvania Grade Crude Oil Assn. (annual meeting), William Penn Hotel, Pittsburgh, Pa.

18-19 Western Petroleum Refiners Assn. (regional meeting), Conrad Hilton Hotel, Chicago, Ill.

25-26 Rocky Mountain Oil and Gas Assn. (midyear director's meeting), Utah Hotel, Salt Lake City, Utah.

28 to July 2 Petroleum Equipment Suppliers Assn. (annual meeting), Broadmoor Hotel, Colorado Springs, Colo.

29 to July 3 American Socy. for Testing Materials (annual meeting), Chalfonte-Haddon Hall, Atlantic City, N. J.

AUGUST, 1953

17-19 Socy. of Automotive Engineers (international West Coast meeting), Georgia Hotel, Vancouver, B. C., Canada.

18-21 National Congress of Petroleum Retailers, William Penn Hotel, Pittsburgh, Pa.

SEPTEMBER, 1953

6-11 American Chemical Society (124th national meeting), Conrad Hilton Hotel, Chicago, Ill.

9-11 Oil Industry Information Committee, Cleveland Hotel, Cleveland, Ohio.

13-16 American Inst. of Chemical Engineers, Fairmont and Mark Hopkins Hotels, San Francisco, Calif.

14-17 Socy. of Automotive Engineers (National Tractor Meeting and Production Forum), Schroeder Hotel, Milwaukee, Wis.

15-16 American Petroleum Institute (Executive Committee), Greenbrier Hotel, White Sulphur Springs, W. Va.

16 American Petroleum Institute (Division of Marketing, Lubrication Committee meeting), The Traymore, Atlantic City, N. J.

16-18 National Petroleum Assn. (51st annual meeting), The Traymore, Atlantic City, N. J.

21-23 American Trade Assn. Executives (annual meeting), Chalfonte-Haddon Hall, Atlantic City, N. J.

24-25 Western Petroleum Refiners Assn. (regional meeting), Henning Hotel, Casper, Wyo.

27-29 National Assn. of Oil Equipment Jobbers (annual meeting), Neil House, Columbus, Ohio.

29 to Oct. 3 Socy. of Automotive Engineers (national aeronautic meeting), Statler Hotel, Los Angeles, Calif.

OCTOBER, 1953

5-7 Texas Mid-Continent Oil and Gas Assn. (34th annual meeting), Rice Hotel, Houston, Texas.

7-9 National Assn. of Corrosion Engineers, South Central Region (annual meeting), Mayo Hotel, Tulsa, Okla.

11-17 Oil Progress Week.

14-15 Indiana Independent Petroleum Assn. (fall convention), Severin Hotel, Indianapolis, Ind.

15-16 Petroleum Marketers Assn. of Texas (annual meeting), Adolphus Hotel, Dallas, Tex.

19-20 Independent Petroleum Assn. of America (annual meeting), Hotel Texas, Ft. Worth, Tex.

19-23 National Safety Congress, Conrad Hilton, Congress, Morrison, Sheraton, Chicago, Ill.

22-23 Western Petroleum Refiners Assn. (regional meeting), Garrett Hotel, Eldorado, Ark.

26-28 National Lubricating Grease Institute, 21st Annual Meeting, Edgewater Beach Hotel, Chicago, Ill.

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FUTURE MEETINGS

OCTOBER, 1953

28-29 Independent Oil Compounders Association, 6th Annual Meeting, Edgewater Beach Hotel, Chicago, Ill.

29-30 Socy. of Automotive Engineers (international production meeting), Royal York Hotel, Toronto, Ontario, Canada.

NOVEMBER, 1953

2-4 Socy. of Automotive Engineers (national transportation meeting), Conrad Hilton Hotel, Chicago, Ill.

2-4 American Oil Chemists' Socy. (27th fall meeting), Sherman Hotel, Chicago, Ill.

3-4 Socy. of Automotive Engineers (national diesel engine meeting), Conrad Hilton Hotel, Chicago, Ill.

4-5 Nebraska Petroleum Marketers (annual convention), Paxton Hotel, Omaha, Nebr.

5-6 Socy. of Automotive Engineers (national fuels and lubricants meeting), Conrad Hilton Hotel, Chicago, Ill.

9-11 The Geological Society of America (annual meeting), Royal York Hotel, Toronto, Ontario, Canada.

9-12 American Petroleum Institute (33rd annual meeting), Conrad Hilton Hotel and Palmer House, Chicago, Ill.

29-Dec. 4 American Socy. of Chemical Engineers, Statler Hotel, New York, N. Y.

30 to Dec. 5 Twenty-fourth Exposition of Chemical Industries, Grand Central Palace, New York, N. Y.

DECEMBER, 1953

13-16 American Inst. of Chemical Engineers (annual meeting), Jefferson Hotel, St. Louis, Mo.

JANUARY, 1954

11-15 Socy. of Automotive Engineers (annual meeting and engineering display), Sheraton-Cadillac and Statler Hotels, Detroit, Mich.

FEBRUARY, 1954

8-9 Missouri Petroleum Assn. (annual convention), Chase Hotel, St. Louis, Mo.

MARCH, 1954

1-5 American Socy. For Testing Materials (spring meeting), Shoreham Hotel, Washington, D. C.

2-4 National Passenger Car, Body, and Materials Meeting, Hotel Statler, Detroit, Michigan.

APRIL, 1954

12-15 National Aeronautic Meeting, Aircraft Engineering Display, and Aircraft Production Forum, Hotel Statler, New York, N. Y.

MAY, 1954

2-4 Independent Petroleum Assn. of America (midyear meeting), Cosmopolitan Hotel, Denver, Colo.

JUNE, 1954

6-11 Summer Meeting, The Ambassador and Ritz-Carlton Hotels, Atlantic City, New Jersey.

13-18 American Socy. for Testing Materials (annual meeting and exhibits), Sherman Hotel, Chicago, Ill.

AUGUST, 1954

16-18 National West Coast Meeting, Los Angeles, Calif.

SEPTEMBER, 1954

12-16 National Tractor Meeting, Los Angeles, Calif.

OCTOBER, 1954

4-9 National Aeronautic Meeting, Aircraft Engineering Display, and Aircraft Production Forum, Hotel Statler, Los Angeles, Calif.

Week of
Oct. 18 National Transportation Meeting, Boston, Massachusetts.

25-27 National Lubricating Grease Institute (22nd annual meeting), Mark Hopkins Hotel, San Francisco, Calif.

26-27 National Diesel Engine Meeting, Hotel Statler, Cleveland, Ohio.

NOVEMBER, 1954

1-2 Independent Petroleum Assn. of America (annual meeting), Shamrock Hotel, Houston, Texas.

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October 26 - 28

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NLGI Annual Meeting

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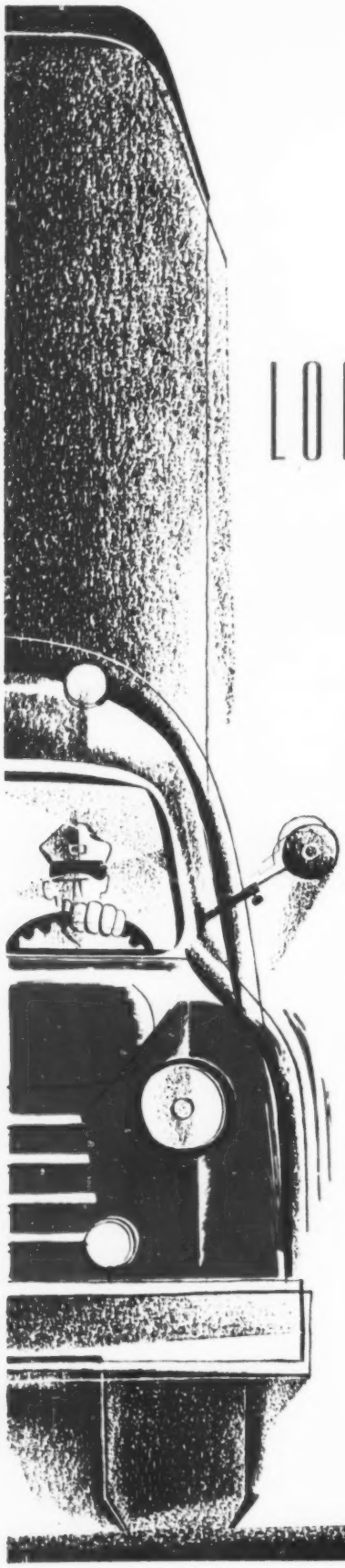

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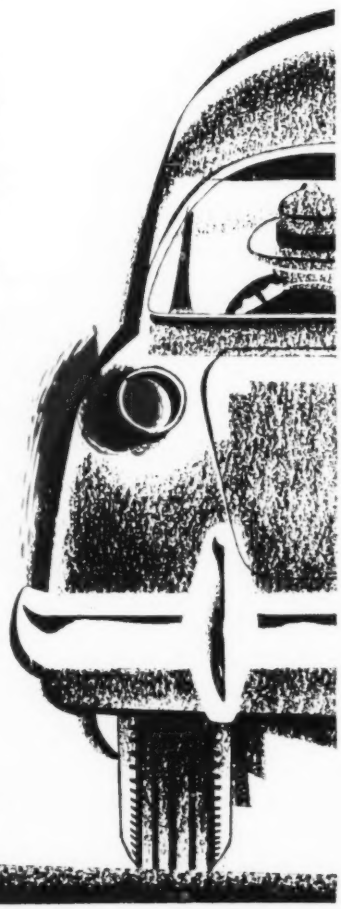

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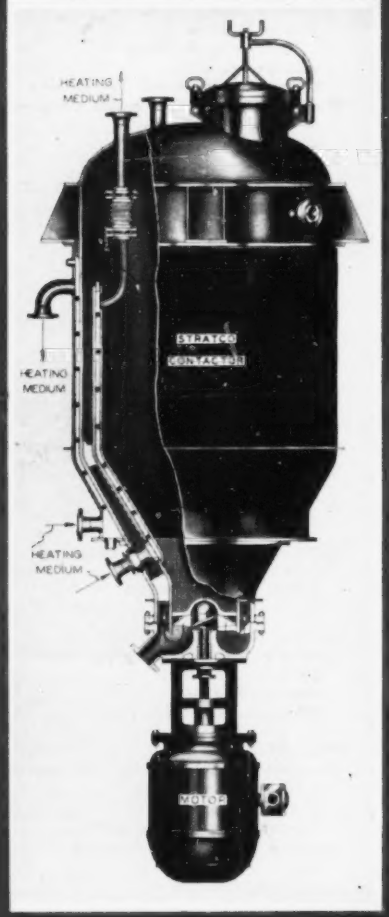

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